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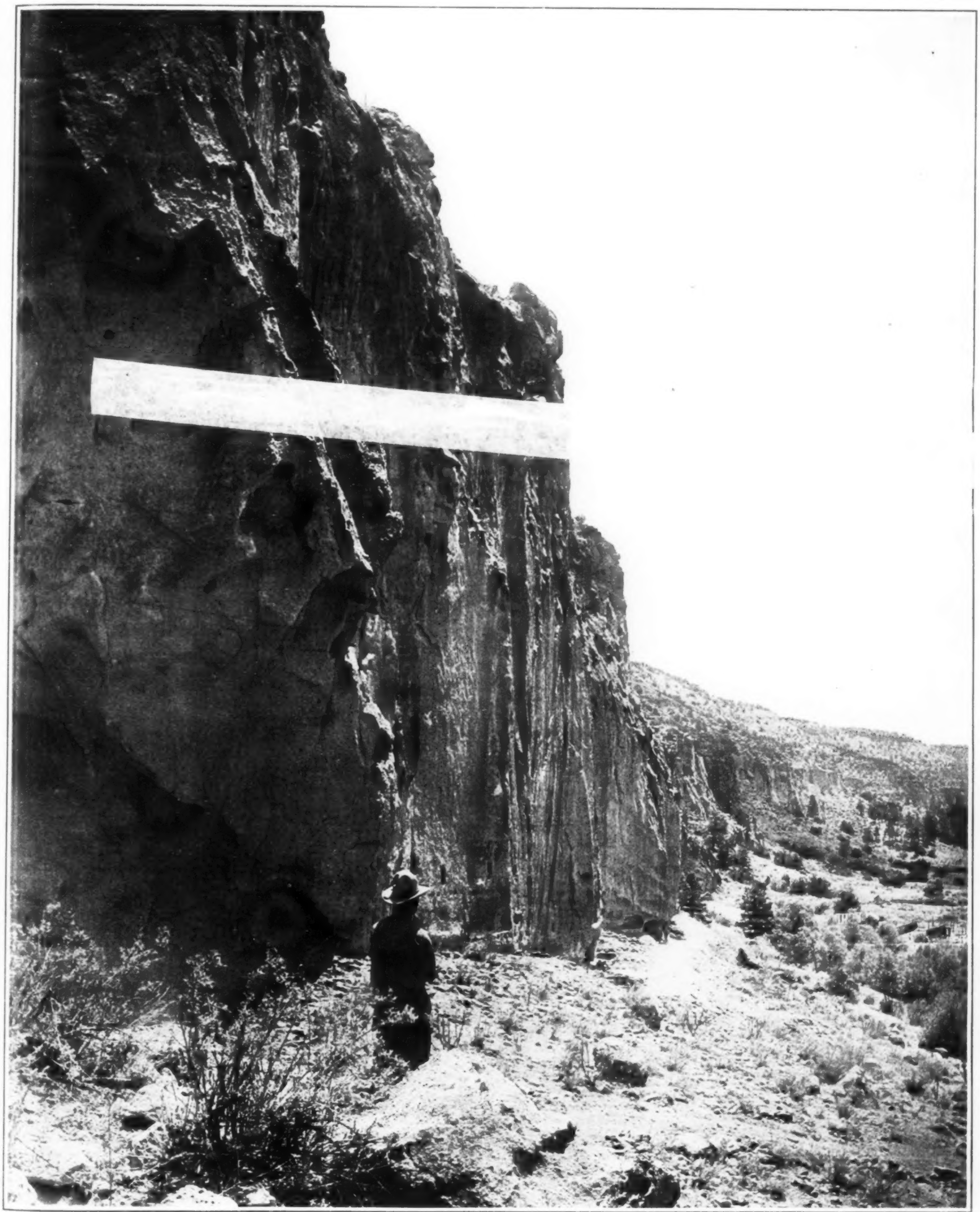


The perpendicular cliff of Frijoles Canyon, showing the remains of early rock dwellings

LOST CITY (see page 216)

The Microscope in Metal Study*

Some of the Difficulties of Illumination and How They Are Met

By Henry M. Sayers, M.I.E.E.

THE use of the microscope for the examination of metals is now so common in laboratories and works that it might be expected that the manipulative principles would have become a matter of routine. But personal observation in a number of laboratories, and the examination of numerous micro-photographs, shows that in a good many cases the results obtained are not so good as they might be, and that the defects are mostly traceable to lack of understanding of the principles of illumination as applied to opaque objects.

For low-power work, involving the use of nothing higher than a 1-in. or 2/3-in. objective, illumination presents no particular difficulties. A parabolic side reflector serves for oblique illumination, and a microscope cover glass, set at 45 deg., between the objective front and the object, serves for vertical illumination. In either case, the use of a condensing or parallelising lens between the source of light and the reflection, permits of a light concentration of ample intensity for either visual or photographic work.

For higher powers, some form of vertical illumination placed above the objective is necessary. This illuminator takes various forms. The simplest is that of a thin glass set at 45 deg. to the optical axis, receiving light through an aperture cut in the side of the fitting, which forms a part of the microscope tube. This light is partly reflected downwards through the objective on to the specimen. The objective in this case acts as a condenser, concentrating the light upon the specimen. It is obvious that the presence of this reflector leads to considerable diminution of the light intensity received from the source. In the first place, only a part of the beam is reflected downwards, the remainder passes through the glass, and is lost on the black coating of the tube. The converse action takes place on the upward image-forming beams emerging from the objective, part of these are reflected back toward the source of light, only the remainder pass through the glass towards the eyepiece. This happens also when the reflector is between the objective and the object. Therefore, to obtain an image of sufficient intensity for comfortable observation, still more to obtain an image of sufficient intensity and contrast for reasonably short exposures in photographing, the source of light must be of considerable intensity. For photography, it must be of good actinic power. It is usual to provide arc lamps for this work, and nothing better than the positive crater of a continuous current arc is available. Sufficient care is not always taken to adjust the arc in relation to the condensing lens to utilise the crater radiation. In the case of relatively long exposures there is a possibility that the crater may change position owing to the consumption of carbon, to imperfect feeding of the lamp, or to the arc shifting its position. Attention to these points, especially to getting as much of the crater surface as possible directed to the condensing lens, and protecting the arc from draughts, is well repaid by the results.

Another very satisfactory source is the Nernst lamp, with a straight filament. The small diameter of the filament is a drawback, which has to be overcome by the use of a suitable condensing arrangement, giving, in result, a magnified image of the filament as the virtual source of light. A 1-amp. 100-volt lamp gives good results. Photographing will require longer exposures than with an arc lamp. On the other hand, the Nernst lamp consumes much less energy, does not vary, and has no mechanical adjustments to worry about. Unfortunately, Nernst lamps are only made in Germany, and there is now no supply available.

So far as present experience goes, no form of incandescent lamp comes near the arc or Nernst lamp for metallographic purposes. A half-watt closely-coiled straight filament lamp, as supplied for motor-car headlights, gives fairly good visual results, but requires long exposures for photography. The Gillingham tungsten arc "Point-o-lite," seems promising, but having had no opportunity of using it, the writer cannot speak from experience.

The greatest difficulty encountered by a beginner, and one which a great many experienced operators never seem to overcome in a satisfactory way, is to obtain an image free from glare and commensurate in its qualities of resolution and definition with the optical power available. This can only be secured by conformity with certain optical principles, which are not difficult to grasp. Of course, if one goes to a first-class maker, and orders a metallographic microscope outfit regardless of cost, the maker will (or should) have designed and disposed the whole outfit, illuminant, condensing system and microscope so that these conditions are automatically fulfilled if instructions are carried out.

But equally good work can be done with a microscope outfit used for other purposes, and, therefore, entailing much less expense, if the operator understands the principles.

The most common trouble is that covered by the word "glare." The origin of this is quite simple. The light from the reflector passing down through the objective is partly reflected from the lenses towards the eyepiece, and superimposed upon the light of the image proper. This reduces its sharpness, contrast, and obliterates fine detail. It is confusing to visual observation, and disastrous to photography. The reflection takes place almost entirely from the convex surfaces of the objective lenses. Such reflection cannot be prevented. The only thing that can be done is to arrange that the reflected light shall be scattered to the sides of the tube, and there absorbed. It may be said in passing, that the prevention of reflection from the tube sides into the eyepiece is of the greatest importance in this use of the microscope. Such reflection can be detected at once by looking down the tube with the eyepiece withdrawn, and the means of prevention by re-blacking, the use of a black diaphragm below the eyepiece, etc., will be obvious.

Now, the reflecting surfaces which cause glare are convex towards the eyepiece. In accordance with the ordinary laws of reflection, therefore, a beam of parallel light will be scattered laterally, excepting for the ray falling normally on the convex surface, which will be reflected normally. A beam of diverging rays will be more scattered with a similar exception. A beam of converging rays will, however, be reflected towards the eyepiece from an appreciable area of the lens, larger or smaller, according to the amount of convergence and the curvature of the lens. These conditions can be detected at once by looking down the tube with the eyepiece withdrawn. If the light falling on the upper objective lens is either parallel or divergent only, a tiny point of light will be seen in the centre line of the objective. If the light is convergent, a larger or smaller image of the source, or of the aperture through which the light enters will be seen. In the latter case, when the eyepiece is inserted, it will be found that this light yields a bright field, which is superimposed upon the image of the object. Hence, to avoid glare, the light meeting the upper objective lens must be either parallel or divergent. Fortunately, this condition is also consistent with the best performance of the objective in regard to resolution of detail and accurate definition.

There is another source of glare which ought to be mentioned. If a "dry" objective of high power is used, this cannot be eliminated. It is due to a part of the light from the specimen being reflected back on to it from the front lens of the objective. As this light is for the most part in a different direction to the true illuminating beam, passing through the objective from the reflector, it has the effect of reducing the contrast in the resultant image. There are, in effect, duplicate images lighted by rays in different directions, superimposed. For all magnifications requiring the use of objectives higher in power than a half-inch, it is preferable to use oil-immersion lenses. One-sixth and one-seventh oil-immersion lenses have been made for metallographic use, but the war seems to have impeded their production in this country.

The conditions for obtaining the full benefit of the optical qualities of the objective employed remain to be considered. Other things being equal, the power of an objective to resolve fine structure and give accurate definition, depends upon what is known as its "numerical aperture," shortly, "N.A." To put it non-technically, this means the solid angle of the beam of light from any point of the object which the objective can grasp and bring to a focus in the image plane. It will be clear at once that the larger the angle of this beam, the brighter will be the resultant image, at the same magnification. It must be taken as a proved fact, both on theoretical grounds and from practical experience, that the limit of fineness of structure which can be resolved by an objective also depends upon this light-grasping power defined as numerical aperture. It may be interesting to say here that as a practical result of this fact, with the materials at present available for lenses and immersion media a keen observer can see everything which the best objectives can reveal with a magnification of 700 diameters. It is true that some extension of this power is available by the use of monochromatic light of short wave length, and of ultra-violet light for photography, with special objectives, but these extensions are hardly practicable at present for the ordinary worker. They open up fields for research.

Now, the objective cannot grasp light which is not reflected or refracted from the object point, which means that the full "N.A" of the objective cannot be used unless the objective is illuminated by a beam of approximately equal solid angle. For the more common use of the microscope on transparent objects, such a beam of large angle is provided by a condensing system below the stage. The object is then at the same time in the focus of the condenser, which projects upon it an image of the source of light, and of the objective. With vertical illumination, the objective is also the condenser. To get the best results, then, the objective must at the same time focus upon the object an image of the source of light, and focus into the image which is magnified by the eyepiece the surface of the specimen. The distance above the objective at which the image is formed is fixed by the "tube length" of the microscope. This tube length is generally adjustable within certain limits. It is the case, however, that every high-power objective is designed and corrected for a definite tube length, at which it gives the most perfect image. The maker frequently marks this tube length on the objective and always states it in his catalogues. It may vary between 160 mm. and 250 mm. For such use as now considered, it is a fixed dimension for any objective, and to get the most perfect image, the objective must be used at that tube length. Practically the tube length is measured between the flange of the objective, which meets the nose piece, and the flange of the eyepiece which meets the body tube.

Now, the distance between an objective and an object, and between the objective and the focussed image of the object are reciprocal, *i. e.*, if the object is put in the place of the image, an image of the object will be formed at its former position. The relative sizes will also be inverted, *e. g.*, if the objective is so focussed as to give an image with a magnification of 100 diameters, it is also so focussed as to produce on the object plane an image of one-hundredth the lineal dimensions of any object placed in the (normal) image plane; and it is not focussed to produce on the object plane an image of anything at a greater or less distance. Hence, for the objective to act in the best possible way as a condenser, *i. e.*, to focus on to the object a reduced image of the source of light, that source must be at the same distance from the objective as the image in the microscope tube.

So the very simple rule is that to get the best results, the source of light must be at tube length distance, measured along the path of the beam, from the objective. This does not mean necessarily that the actual lamp must be at that distance. This may be inconvenient for many reasons. In the case of a Nernst lamp, for example, the width of the filament is so small that under these conditions the image of the filament would give in the field a streak of light too narrow to show a useful extent of the specimen. The condition is fulfilled if the light entering the objective from the reflector is divergent to the same extent as if it were proceeding from a source at tube length distance. This will be the case if the light from the source is condensed into an aerial image at that distance. This aerial image is most conveniently focussed on an iris diaphragm, placed at tube length distance, which diaphragm can be adjusted to give the necessary intensity of illumination. In the case of a light source of small width or area, this aerial image should be magnified by the condensing lens to give a sufficient width to the image formed by the objective. It may be noted here that the distance between the light source and its magnified image depends upon the amount of magnification and the focal length of the condensing lens. The shorter the focus of the lens, the smaller the distance required for any given magnification. On the other hand, the smaller also is the distance between the source of

*From *Engineering*, London.

light and the lens, and, therefore, the greater the heating of the lens. For this reason, a longer focus lens and a greater overall length of bench is needed for an arc lamp than for a Nernst or other filament lamp. For the latter, a condenser of about 2 in. focal length can be safely used. With an arc lamp such a lens would be quickly destroyed. Something like a 6-in. focus lens may be found necessary. This question of distance or length of bench needed, becomes very awkward where space is limited. Some ingenuity can be profitably spent on reducing it by the use of mirrors, etc. Great care is necessary in centering the source to the auxiliary condenser, or an uneven illumination will result.

It will be observed that the best condition for avoiding glare, *i. e.*, the use of a diverging beam, coincides with the best utilisation of the objective as a condenser.

As no image of a light source can be so bright as the light source itself, and a magnified image must, obviously, be much less intense, the best theoretical conditions for brightness of image and shortness of photographic exposure are met by having the source of light itself at the tube distance, and dispensing with all auxiliary lenses between it and the objective. Unfortunately, most of the practicable light sources are too small in area for such direct use. This can be easily realised by remembering that the diminution of the image of the source by the objective acting as a condenser is exactly the same as the magnification of the illuminated part of the object at the image plane. Thus, an arc lamp crater of .125 in. diam. (which corresponds roughly to a 10-ampere arc) would give an image of the same diameter in the image plane. Supposing the eyepiece to have a power of 10 diam., the apparent size of the illuminated field would then be 1.25-in. diam.—seen at the normal vision distance of 10 in., while the full microscope field may be from 4 in. to 6 in. diam. This means that only one-tenth of the extent of the object is visible, compared with that of the whole field. Hence, even a 10-ampere arc crater needs magnifying over three diameters to fill a normal field with critical illumination. What happens in ordinary practice is that the light source, actual or virtual, is used at such a distance from the objective that the field is filled with light, unfocussed, and, therefore, far from representing the best illumination conditions. This accounts for the mediocre results generally obtained and accepted because the superiority of the image under the best conditions is not known.

There is one more observation as regards the utilisation of the full "N.A." of the objective. Seeing that metallurgical specimens are approximately plane surfaces, the angle of reflection is equal to the angle of incidence. Consequently the maximum angle of the bundle of rays reflected from any point on the object towards the objective is the same as the angle of the bundle of rays condensed on to the objective considered as a condenser. This means that the resolving power (*i. e.*, the "N.A") utilised is limited by the diameter of the beam falling on the back lens.

As a general rule, the full "N.A." which an objective can use is realized when two-thirds of the diameter of the back lens is filled by the beam. In vertical illuminator fittings, as generally supplied, the aperture for the entrance of the beam rarely admits so much, even allowing for the divergence between that point and the back lens. Now, the first instinct of a worker who is troubled by glare is to reduce this aperture, and it has the desired effect. But it also reduces resolving power, and produces a spurious thickening of outlines which may amount to a considerable misrepresentation of the structure observed, besides suppressing detail well within the capacity of the objective properly used. Therefore, the regulation of brightness should be effected by the iris diaphragm at or near the virtual light source, and glare avoided by the arrangements set out above. It may be usefully mentioned that a considerably greater brightness of image can be used in photographing than is comfortable to the eye. This can be judged of on the focussing screen.

It may also be mentioned that the arrangements can be tested on an object of known structure, such as a diatom, which must be mounted in balsam or realgar. For example, Amphipleura pellucida mounted in balsam can be readily resolved into lines, 100,000 per in., with a good 2 mm. oil immersion objective and vertical illumination, better resolved, in fact, than with the same objective by transmitted light. This is as much as can be expected in metallography with our present resources.

SUMMARY.

1. The virtual source of light should be located at tube-length distance from the objective measured along the course of the beam. Or, otherwise expressed, the light falling on the back lens of the objective should diverge as if it came from a source at that distance.

2. The practical test of this condition is that the image of the source of light is sharply focussed on the object at the same time that the object is seen focussed in the field.

3. To obtain the maximum resolving power from the objective, the beam falling on the upper lens from the reflector should approximate two-thirds the diameter of the lens.

4. If the actual light source placed at tube length distances gives too small an image to fill a sufficient proportion of the field for satisfactory observation, a magnified real aerial image of it must be formed at that distance of sufficient area to fill the field.

5. To modify the brightness of the image to suit visual and photographic requirements, use a diaphragm either in the plane of the aerial image or at the auxiliary condenser, not between the objective and the image of the source.

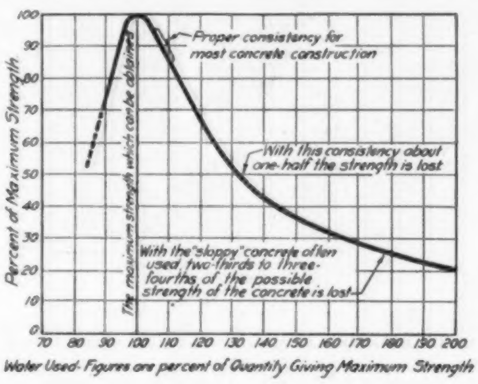
6. For magnifications requiring objectives of shorter focus than ½ in. (12 mm.), use oil immersion objectives.

7. If doubtful of the efficacy of the arrangements, use a suitably mounted diaton of known fineness of structure as a test object.

Effect of Water on Strength of Concrete

For some time experiments have been in progress at the Structural Materials Research Laboratory, Lewis Institute, Chicago, to determine the effect of various quantities of water on the strength of concrete. These experiments have been directed by Duff A. Abrams, Professor in Charge of the Structural Materials Research Laboratory.

Prof. Abrams has reduced his experiments to an intelligible form, which is interpreted by the accompanying diagram. This summarizes the results of compression tests on 6 by 12-inch concrete cylinders made in mixes ranging from 1 part cement and 9 parts aggregate, to 1 part cement and 2 parts aggregate, by volume. These mixes represent concretes of all qualities from the leanest to the richest which are generally used for any purpose. The aggregate consisted of a mixture of sand and pebbles graded in size from the finest particle up to 1¼ inch. Exactly the same grading was used in all cases.



These tests show that the effect of proportional changes in the mixing water is approximately the same for all mixes of concrete; consequently a composite curve has been drawn to show the average effect. The vertical distances represent the relative strength of concrete, expressed as a per cent. of the maximum which can be secured from a given amount of cement and the same aggregates. The horizontal distances indicate the relative quantity of water used in the mix, considering the amount which gives the maximum strength as 100 per cent.

The amount of water which gives the maximum strength in concrete produces a mix which is too stiff for most purposes. In plants where such products as building units, drain tile, sewer pipe, etc., are manufactured it is desirable to use a mix even drier than that which gives the maximum strength. The molds can thus be removed within a short time; this would be impossible if a wetter and more plastic mix were used.

It will be noted that the concrete strength increases rapidly with the quantity of water over the range indicated on the diagram. With any further increase in the amount of water there is a rapid falling off in strength, as indicated by the curve. With an amount of water about double that required for highest strength, the concrete has only about 20 per cent. of the maximum strength.

The exact amount of water corresponding to the maximum strength of concrete will vary with the method of handling and placing the concrete. Any method which involves puddling, tamping, rolling or vibration, or the exertion of pressure in any manner, will have a tendency to increase the strength of the concrete regardless of the amount of water used. However, it is probable that the effect produced by these methods will be more pronounced in the consistencies in the vicinity of the maximum strength.

Corrosion of Brass in Sea Water*

By Paul T. Bruhl

The corrosion of brass has long been investigated, notably by a committee appointed by the Institute of Metals (London), and experiments have been conducted not only to throw light on the various factors governing the rate of corrosion but also to suggest some other alloy as a substitute for brass if sufficiently effective protective measures cannot be found.

Brass may be said to corrode in two ways; in the first the action is merely mechanical and the metal is abraded; in the second and more dangerous way it is either attacked uniformly over its entire surface of corrosion is strongly localized and we have the phenomena of dezincification and pitting. As the strength of a chain is that of its weakest link, so that of a condenser tube depends upon the length of time which suffices for the development of the first perforation.

In the investigation of the effect of strain it was found that the method of manufacture does not permit of any difference in solution pressure greater than 0.0002 volt. This factor contributing to the rate of corrosion is therefore not a serious one; the anodic areas merely act as loci at which corrosion tends to start and from which it spreads over the whole surface.

The bearing on the subject of annealing—with respect both to time and temperature—has been shown to be small, though annealing by increasing the electromotive force increases the liability to attack. It must always be remembered, however, that corrosion is a complex problem and the reactions it involves are difficult to foretell; so that observations made at the beginning may not hold good at the end of an experiment.

Rolling of the metal has an influence inasmuch as it increases the tendency to corrode by imparting to the metal an added energy, though the solution pressure is diminished by closer agglomeration of molecules.

Bilge water and organic oils are harmful, the former owing to the formation of corrosive sulphur compounds, the latter because of the decomposition by steam into products containing free acid.

Stray currents of electricity undoubtedly exert a pernicious effect by causing more rapid removal from the solution of the charged ions. Mr. Milton in discussing this point said, "If, for instance, there is a leakage from the positive cable in such a position that part of it proceeds to the sea (earths) through the water flowing through the condenser tubes, which are, of course, clean metal, instead of through the hull of the vessel, which is kept painted in order to prevent any actual contact between the iron and the sea water, some electrolytic action must take place in the tubes themselves."

The main consideration in any research on the corrosion problem ought to be the determination of the circumstances which give rise to pitting. Three factors govern the positions of the serious pits; mechanical defects, the presence of certain deposits which act as cathodic centers, and dezincification, that is to say, the preferential solution of the zinc. A spill must be a source of danger (though some do not hold it to be so) as the metal wall where it occurs is thinner and hence corrosion has not so far to proceed to cause a perforation. The deposits which are generally conceded to be injurious are the green oxychloride (which promotes dezincification), carbon and ferric hydrate.

A study of the effect of physical constitution on corrosion has been made. For instance, Muntz metal, which contains 60 per cent. copper and 40 per cent. zinc, is built up of the alpha and beta phases and the voltaic action between the two accelerates the rate of corrosion, so that at first, before secondary reactions set in, Muntz metal corrodes faster than 70/30 brass which consists of the alpha phase only.

Control of the condenser temperature through the provision of an adequate area of condensing surface, the use of electrochemical protection, the substitution for brass of other metals such as phosphor-bronze, monel metal, alloys of copper and aluminium, and brass with 2 per cent. lead, have all been suggested as aids to the partial prevention of corrosion.

Other interesting observations that have been made are that up to a certain point dilution of aëration of the sea water, and in general a rise in temperature or an increase in the amount of CO_2 present, promote the corrosion of brass.

*From *Chemical and Metallurgical Engineering.*

Marsh hawk, adult male and young

Goshawk, adult and young

Sharp-shinned hawk, adult and young

Birds and the Farmer

The Hawks of the Canadian Prairie Provinces in Relation to Agriculture

By P. A. Taverner of the Canadian Department of Agriculture

THE hawks have long been regarded as pariahs among birds and have been killed whenever occasion offered. Poultry-men and game conservators have been especially bitter in their persecution of them. Legislatures have not only refrained from protecting these birds, but in some cases, have placed bounties on their heads. The results have not always been satisfactory and when ailing game which would have been destroyed by the hawks have transmitted their diseases to healthy birds, or rodents or other vermin have increased to plague numbers, we have often had cause to regret hasty action. To-day, when the whole world is straining every nerve to increase the food supply, the status of these birds becomes of even more pressing importance than formerly and it is necessary that their economic effect be scrutinized carefully.

An investigation was made by the United States Department of Agriculture in 1893 and the results embodied in Bulletin No. 3, "The Hawks and Owls in the United States in their relations to agriculture." The examination of some 2,690 stomachs proved that though a few species could be thoroughly condemned, the majority did enough good to counteract the evil they did, and others were altogether beneficial. Since that time much additional information has been gathered which substantiates all the conclusions then drawn. Season and locality enter largely into the subject; a species may be harmful at one season or in one place and beneficial at other times or places where conditions are dissimilar, where other food is available, or other interests are at stake. Considering the great number of hawks that range the prairie provinces and the large interests at stake it seems desirable to point out clearly the economic status of these important species.

In the prairie provinces of Canada there are some sixteen species of hawks and two eagles. Some of these are of too rare occurrence to require more than passing notice, but others are common enough to have important economic influence. The hawks can be divided into seven groups, each having common characters that aid in its recognition and reflect its habits: (1) Vultures or carrion eaters; (2) Harriers or marsh and meadow haunters; (3) Accipiters, round-winged or woodland hawks; (4) Buteos, buzzard hawks or soarers, and rough-legs; (5) Eagles; (6) Falcons, noble or long-winged chasers; (7) Ospreys or fish hawks.

The vultures are represented by only one species in Canada, the turkey vulture *Cathartes aura*. This is sometimes called turkey buzzard, though strictly speaking it is not a true buzzard—a term which can be correctly applied only to one of the following groups. It is found in the more southern parts of the prairie provinces, but, as it confines itself strictly to carrion and is unfitted by physical structure for aggression, its effect is neutral or wholly beneficial. There are tales of its picking out the eyes of young lambs, but there is certainly little danger of its doing this unless the mother is unable to put up even a slight show of defence.

The turkey buzzard can be easily recognized by its large size (30 inches long) and sooty black color unrelieved except by the red of its bare, featherless head and neck, which is plainly visible at considerable distances.

The harriers are represented by only one species, the marsh hawk (*Circus hudsonicus*). In life it is a rather large-appearing hawk (19-22 inches long), but in the hand the smallness of its body and the lightness of its construction are evident. It has not the strength nor the weight for attacking any but small prey. It beats about over the marshes, meadows, or open fields and subsists almost wholly on mice and such small fry. Occasionally small birds are taken, and small ducks that have been wounded are sometimes attacked by it, but it rarely if ever threatens whole or healthy birds of this size. Young chicks of both wild and domestic species are taken on occasion, but it usually avoids the immediate vicinity of buildings and has not often the courage to swoop on the poultry yard. The young grouse it takes must be counted against it, but as out of 124 stomachs examined only one contained evidence of this, such cases are probably the result of occasional opportunity, rather than regular habit. The number of mice it takes is large and it must be ranked high as a mouser. It is, therefore, a bird that is strictly beneficial and should have every protection.

The marsh hawk when flying exhibits long pointed wings and a long narrow tail. In outline, therefore, it resembles the falcons, but its tail is longer than theirs and its action and habit of flight very different. It usually flies low, beating, with regularly measured, leisurely strokes, up and down over waste land and low scrub, rising with even sweep to surmount a woodel fence line or copse, and plunging rapidly down again to surprise unsuspecting prey on the other side. The young bird of the year is practically reddish brown all over and the adult female is similar but lighter below with the red less intense. The adult male is nearly pure white below and pearl grey above, with black wing tips. In any plumage the marsh hawk can be recognized by its white rump which stands out conspicuously and forms a good field recognition mark, especially in juvenile red plumages.

The accipiters are represented by three species. They vary in size from the sharp-shinned, the smallest of our hawks, with body hardly larger than that of a robin, to the goshawk, one of the largest and most powerful of the hawks. Normally they are woodland hunters and glide through the open bush, threading its

Red-tailed hawk, adult and young

Swainson's hawk in two phases

Duck hawk, adults and young

mazes with speed and certainty and taking their prey by hidden approach and sudden surprise. For this purpose, which demands sudden bursts of speed and powerful manœuvring control, they have short rounded wings and long tails, giving an outline that taken with flight habits is quite characteristic. They fly with several quick wing beats and then a short sail and are seldom seen beating about the open, soaring in the air, or, except in migration, far from the vicinity of timbered areas. In spirit they are bold and aggressive and their depredations are serious. The two smaller species, the sharp-shinned and cooper's hawks, subsist almost entirely on small birds, paying little if any attention to mice or rodents. The goshawk takes larger birds and the larger rodents and other such mammals. These birds have done most to give the other raptores a bad name among poultry raisers and game conservators. The sharp-shinned is limited by size to small birds and is only indirectly important, but the goshawk is a confirmed chicken and grouse thief. The cooper's hawk, being smaller, cannot do as much harm, but the difference is one of degree only and little can be said in its favor.

The adult goshawk is easily recognized. It is a large hawk (length 22 inches), slate grey all over, vermiculated across the breast with many fine, dark zigzag lines. The young of the year is more difficult to recognize and resembles several other species in general style of coloration. All the accipiters in this plumage are very similar and are most easily separated from each other by size. They are brown above, nearly white below, with many narrow, sharp, dark stripes[1] beginning at the throat and covering all the underparts. There are several light bars across the tail and numerous finer ones displayed on the underside of the spread wing. Several other hawks of entirely different economic status have a similar juvenile pattern, but in no common hawk are the stripings below as sharp, regular, and evenly distributed as in these species.

The sharp-shinned and cooper's hawks though similar to the goshawk in the younger stages are different when adult, but are so much like each other as to be scarcely separable by plumage characters. The old birds are dull slate blue above and white below, with the breast and flanks heavily barred with narrow, wavy lines of dull reddish. These two when adult and all three in juvenility are most easily told apart by size. The sharp-shinned is very little larger than a robin in actual size (length 11¼—13½ inches) though looking somewhat larger in life owing to large wings and tail. The goshawk is somewhat larger than a crow (length 22—24 inches) and the cooper's hawk (length 15½–19 inches) is intermediate between the goshawk and the sharp-shinned. As the females of all the hawks are larger than the males a large female of a small species may be almost as large as a small male of the next larger one. However, all three are equally obnoxious in proportion to their size and little mistake can be made in killing any of them.

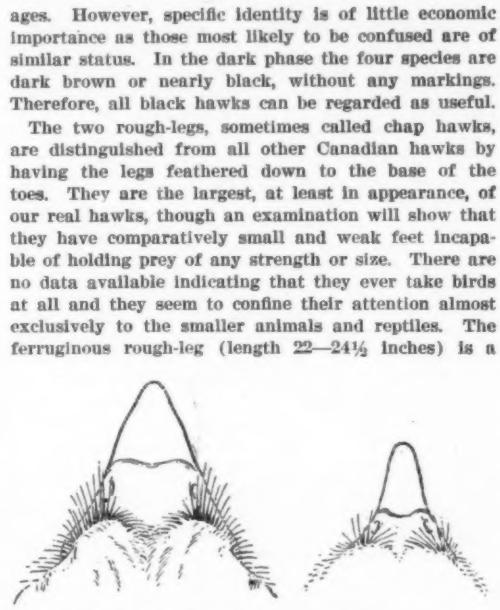
The buteos, buzzards, or sluggard hawks and the rough-legs—represented by four species, the red-tailed, Swainson's, American rough-legged, and ferruginous rough-legged hawks—are all hawks of the largest size and have with very little reason been blamed for the destruction caused by the accipiters. They are birds of the open and are often seen sailing high in the air where their rounded wings and broad spread tails make them usually quite recognizable as a class. When hunting they come lower down, sailing and leisurely flapping over the meadows and fields much like the marsh hawk, though their rounded instead of pointed wings, broad instead of narrow tail, their more leisurely manner, and the absence of conspicuous white rump mark make them easily separable from that species. Their principal food is mice and other small or open-ground rodents and they lack the agility necessary for the successful pursuit of more active game. Throughout the prairie provinces they are inveterate gopher hunters and the number of these pests estimated to be taken by them awakens astonishment. The grand total for one family for the summer season would be 350 gophers. A single gopher under favorable circumstances can and does destroy in the neighborhood of one bushel of wheat. Supposing that one-tenth of this can be charged against the average gopher we still have some thirty-five bushels of grain as the value of one family of these large hawks. At $2.20 per bushel this makes the very substantial amount of $77.

The separation between these four buzzard hawks is complicated by the fact that they all occur in two color phases, a dark one practically similar in all four species and a light one more or less characteristic for each. In each species all degrees of intermediates exist, making an almost bewildering array of plumages. However, specific identity is of little economic importance as those most likely to be confused are of similar status. In the dark phase the four species are dark brown or nearly black, without any markings. Therefore, all black hawks can be regarded as useful.

[1]Stripes run lengthwise of the body; bars run across it.

Sparrow hawk, male and female

The two rough-legs, sometimes called chap hawks, are distinguished from all other Canadian hawks by having the legs feathered down to the base of the toes. They are the largest, at least in appearance, of our real hawks, though an examination will show that they have comparatively small and weak feet incapable of holding prey of any strength or size. There are no data available indicating that they ever take birds at all and they seem to confine their attention almost exclusively to the smaller animals and reptiles. The ferruginous rough-leg (length 22—24½ inches) is a common breeder in the southern parts of the western prairie provinces. In characteristic light plumage it shows a mixture of reddish and brown above with tail white at base reddening toward the tip; it is pure white below with slight dark marking on flanks; the thighs are closely though finely barred with reddish brown. The American rough-leg breeds in the far north, appearing in the settled parts of Canada only as a migrant. It is a slightly less powerful bird than the ferruginous rough-leg and, coming on the prairies after the gophers have holed up for the winter and before they come out in the spring, is of less economic importance. It confines itself to mice and such small vermin, and, therefore, is decidedly useful.



Wide bill of ferruginous rough-leg, narrow bill of his American cousin

The Osprey

The American rough-leg (length 20–22 inches) in its most characteristic light plumage is brown above, more or less mixed with lighter tints, especially towards the head (usually ochres and cream tints with little if any reddish admixture). Below, it is ochraceous dull cream, or white with a pronounced broad black or dark brown band across lower breast and abdomen. The tail is nearly white at the base and brown towards the tip. Between the light and the dark phases of these birds all intermediates exist and often the two rough-legs are most difficult to tell apart except by a comparison of the bills. Looking down (towards the crown) the bill of the American rough-leg is comporatively narrow (as shown), whereas that of the ferruginous is much broader at the base giving what might be described as a frog-mouthed effect.

Eagles are represented by two species—the bald-headed and the golden. Size is sufficient to distinguish these birds from all other raptores. Any Canadian bird of prey over 30 inches long from tip of bill to end of tail, or over 6 feet in spread of wings, must be an eagle. Eagles are nowhere common enough in the prairie provinces to be of economic importance. The tales current of eagles taking lambs and even young children are either exaggerations or the reports of most exceptional cases. Adult bald eagles are easily recognized by their pure white heads and tails, but in the juvenile plumage their even darkness is so like the coloration of the golden that they are best recognized by their leg characters. The legs of the golden are always feathered to the base of the toes (similar to always feathered to the base of the toes whereas those of the bald are bare from the first joint down.

The falcons, long-winged or noble hawks, are represented by five species, none of which, except the sparrow hawk, the smallest and least harmful, is at all common and most of them are so rare as to be objects of curiosity rather than of economic interest. The principal characteristics of the falcons are their pointed, triangular wings and long, narrow tail. Their flight is a succession of quickly timed wing beats, developing high speeds, and with little gliding. The larger members of the group take their prey mostly by straight pursuit, securing it by superior speed and strength rather than by subterfuge. They are the boldest, hardiest, and most sportsmanlike of all the hawks and if they were of more than rare occurrence would warrant uneasiness on the part of the poulterer or the game protector. As it is they can be disregarded.

The American sparrow hawk, next to the sharp-shinned, is the smallest of our hawks as well as the most beautifully and characteristically marked. The male is bright brick-red on the back and tail, the former barred with dark; the shoulders and crown are slate blue. Below it is white, washed with light reddish tan across the breast where there are numerous round black spots. There are conspicuous black bands across the face in striking contrast to the white background. The female is a duller red on back, shoulders, and tail, also barred with dark, and below is dull cream heavily streaked with rather suffused brown stripes. The face and head carry in slightly subdued form the striking markings of the male.

The principal food supply of the sparrow hawk is insects. Of 320 stomachs examined 215 contained insects, mostly grasshoppers, 89 mice, and 53 small birds. The latter were all taken between late autumn and early spring when insects are not available. There are few better friends to the farmer than this little hawk. Wherever there are dead stubs containing old flicker holes in which it can nest this is a common species throughout southern Canada. It should receive every protection and encouragement and it would even pay to put up nesting boxes for it where no natural nesting places are available. The farmer should regard it as personal damage when one is killed upon his premises.

There is only one fish hawk in Canada, the osprey. It is too rare over most of the mid-western provinces to be seriously considered here. It lives exclusively upon fish and is seldom found away from the larger bodies of water. The fish it takes are rarely of economic importance and there are no substantial grounds for persecuting it.

The hawks, especially the large summer buteos, seem to be the natural substitutes for the coyote as a destroyer of the gopher. Being migrating they are present in the southern prairie provinces only in gopher season and show a marked preference for these animals as food. It must not be supposed that hawks can ever entirely exterminate their prey. However, hawks can largely take the place of the eliminated coyote and assist in the control of the pest. They have advantages over human efforts of trap and poison; they are always on the job, they cost practically nothing, they attend to wastes that are sources of infection to cultivated land, and they go automatically where the food is most plentiful and the need for them is greatest.

Radium and Radio-Activity—II

A Consideration of Some of the Physical and Chemical Aspects

By Charles H. Viol

[Continued from Scientific American Supplement, No. 2256, Page 195, March 29, 1919]

The work of a great many experimenters has shown that these active deposits are complex, consisting of a mixture of various successive radio-active products. The various products in an active deposit exhibit characteristic chemical and physical properties and, by taking advantage of these, separations of the various forms of radio-active matter in the deposit may be effected. These products are always present in unweighably small quantities (due to their short periods), and so these separations must always leave the radio-active material mixed with certain quantities of ordinary inactive matter necessary in order that there may be something tangible with which to work. The active deposit of thorium, collected on a platinum plate, may be dissolved in acid or volatilized by heating the plate to a white heat. In the radium series the first product from the emanation, called radium A, has a period of three minutes. This radium A in disintegrating forms what is called radium B, a product that has a period of 26.8 minutes. Radium B gives rise to beta rays and the product radium C. Radium C, decaying with a period of 19.5 minutes, produces alpha, beta and gamma rays and radium D. Radium D has a longer period, 16.5 years, so that while the active deposit on a substance which has been exposed to radium emanation at first decays rapidly—due to the short periods of radium A, B, and C—there is left a slight residual activity, due to the slow decaying D, and the subsequent products radium E and radium F. The period of radium E is five days, and that of radium F is 136 days. Radium F gives off alpha rays, and we now know that the product which Mme. Curie first isolated with the bismuth from pitchblende residues, and called polonium, is nothing other than radium F, that accumulates in the pitchblende.

The radio-elements now known number about thirty, and may be grouped into three families—the uranium-radium group, the actinium group and the thorium group.

Since the half-decay period of radium is about 1700 years, it is evident that in about 20,000 years practically all the radium now existing will have transmuted, and, in order to account for the presence of radium today, a longer-lived product must be sought. This parent is the element uranium. A number of researches, beginning with the work of Boltwood, McCoy, and of Strutt, have shown that there is a relation between the amount of radium and of uranium in most uranium minerals. Experiments were carried out to test whether the newly-formed radium could be detected in uranium initially freed from radium. The experiments gave negative results, and Boltwood found that there is a long-lived product, ionium, in the series between uranium X and radium.

Actinium is always found in the uranium minerals, and its origin is obscure, though it seems probable that it results as a branch product in the uranium series. That is, one of the products in the uranium series is thought to disintegrate in two fashions, one of the products being actinium, the product of the other method of changing being a substance which finally leads to radium

The accompanying diagrammatic representation of these series of radio-active elements shows the order in which the products occur, their half-decay periods, the rays which they give off in the process of their transmutation, and their maximum valence (Roman numeral).

All of the decay products of the uranium-radium series are found in any geologically old ore containing uranium, the proportionate amount of each product depending upon the rate at which the radio element is undergoing the process of transmutation or decay. For each three million parts of uranium in an old unaltered ore, there is one part of radium. Consequently for each per cent. of uranium oxide (U_3O_8) in a ton of uranium ore, there are 2.5 milligrams of radium element.

Radium of the radio-elements of the uranium-radium series has come to be of more commercial importance than the other members of the series, owing to the fact that it is undergoing the transmutation process rather slowly, requiring 1700 years for the decay of half of any quantity, while the subsequent products, Radium Emanation, Ra A, Ra B and the complex Ra C, are all undergoing a very rapid process of transmutation, resulting in the rapid emission of a succession of rays from each of these products for each atom of radium that transforms. Thus, a radium preparation has the long life of radium, and the high degree of radio-activity contributed by the rapid transmutation of the successive decay products of radium. No other radio-element combines these two advantages in the same degree, the nearest competitor, mesothorium, having a far shorter life than radium, the time required for the transmutation of half of any amount of this element being only 5.5 years.

Pitchblende, the ore from which radium was first produced, occurs in small quantities in several localities in the United States, notably in Gilpin County, Colorado, but so far this ore has not been the source of any radium produced in this country. Carnotite, a potassium uranyl vanadate, is the ore which occurs most extensively in the United States, the most notable deposits being those of southwestern Colorado and southeastern Utah. High-grade carnotite, which is comparatively rare, is a soft, talc-like sulphur-yellow mineral, corresponding essentially to the composition of a potassium uranyl vanadate. The commercial carnotite ore is a low-grade mineral usually found in sandstone formations where the carnotite material acts as a cement for the grains of sand. This low-grade ore contains from traces up to several per cent. of uranium oxide, the workable ore containing from about 0.5 per cent. upward. Owing to the greater amounts of lower-grade ore, the average working ore contains about 1 per cent. of uranium oxide, and consequently each ton of this ore contains 2.5 milligrams of radium element. The great problem of radium production is the economical treatment of these lower-grade ores, which must be conserved because of their more extensive occurrence. The region in which carnotite is mined is remote from railroads, and so the ore must be hauled long distances by burros and wagons. Burros bring the ore from the hills to the wagon roads and the average wagon haul is about forty miles. The ore as found usually consists of a thin layer of sandstone which crops out on the side of a canyon wall and is recognized by the characteristic sulphur-yellow color. The narrowness of the seams makes it necessary to take out a large amount of worthless stone to secure the carnotite ore. The seams are usually in the form of pockets, so that the value of a claim is dubious until it has been thoroughly explored and worked.

The physical nature of low-grade carnotite ore is such as to make possible a mechanical concentration of the values. This is carried out on ore containing 2 per cent. or less of uranium oxide. The methods in use are both wet and dry, and consist essentially in a process of grinding to loosen the carnotite material from the sand grains and then separating the values from the tails by a process of dry or wet elutriation.

The fine powdered concentrates are next subjected to chemical treatment to remove the uranium and vanadium, and then the residue, which still contains the radium, is subjected to further chemical treatment to remove this constituent together with the barium salts present in the ore.

Uranium 1
5,000,000,000 years
alpha rays VI
8% (?)
|
Uranium X_1
24.6 days
beta, gamma rays IV
|
Uranium X_2
1.15 minutes
beta rays V
|
Uranium 2
100,000 years (?)
alpha rays VI
|
Ionium
200,000 years (?)
alpha rays IV
|
Radium
1,700 years
alpha rays II
|
Ra. Emanation (Niton)
3.86 days
alpha rays O
|
Radium A
3 minutes
alpha rays VI
|
Radium B
26.8 minutes
beta, gamma rays IV
|
Radium C_1
(above)

Radium C_1
19.5 minutes
99.97% gamma beta V / alpha 0.03%

/ Radium C_1
10^{-6} sec.
alpha rays VI
|
Radium D
16.5 years
beta rays IV
|
Radium E
5.0 days
beta rays V
|
Radium F
(Polonium)
136 days
alpha rays VI
|
Radium G
non-radio-active IV
Chemically identical
with lead

\ Radium C_2
1.4 minutes
beta, gamma rays III
|
End IV
non-radioo-active
isotope of lead

Uranium Y
15 days
beta rays IV
|
Uranium Z
(hypothetical)
alpha rays V
|
Actinium
Period unknown
beta rays III
|
Radioactinium
19.5 days
alpha rays IV
|
Actinium X
10.2 days
alpha rays II
|
Act. Emanation
3.9 seconds
alpha rays O
|
Actinium A
0.002 second
alpha rays VI
|
Actinium B
36 minutes
beta rays IV
|
Actinium C
2.1 minutes
alhpa rays V
|
Actinium D
4.71 minutes
beta, gamma rays III
|
End IV
non-radio-active
isotope of lead

Thorium
13,000,000,000 years
alpha rays IV
|
Mesothorium 1
5.5 years
beta rays II
|
Mesothorium 2
6.2 hours
beta, gamma rays III
|
Radiothorium
2 years
alpha rays IV
|
Thorium X
3.65 days
alpha rays II
|
Th. Emanation
54 seconds
alpha rays O
|
Thorium A
0.14 second
alpha rays VI
|
Thorium B
10.6 hours
beta rays IV
|
Thorium C_1
60 minutes
65% beta rays V / alpha 35%

/ Thorium C_2
10^{-11} second
alpha rays VI
|
End IV
non-radio-active
isotope of lead

\ Thorium D
3.1 minutes
beta, gamma rays III
|
End IV
non-radio-active
isotope of lead

TABLE OF THE RADIO-ELEMENTS

Showing their places in the scale of disintegration, their half-periods, the types of rays they emit, and their valences.

Chemically, radium is so nearly like barium as to make it impossible to separate the radium from the barium present in the ore by a single operation. Since a ton of average ore contains only a few milligrams of radium, while the ore usually contains in the order of a half per cent. of barium sulphate or other barium salts, it is obviously simpler to regard the chemical treatment of the ore as a process of removing all the barium from the ore. This is carried out in a number of different ways; some wet, as in the Bureau of Mines nitric acid treatment, which is only applicable to coarsely-ground, high-grade ore, or boiling the concentrates with soda, with subsequent acid leaching; or dry methods, such as fusion with alkali or soda, with subsequent solution of the insoluble radium-barium-calcium residue in acid.

The next step in the preparation of radium salts consists in subjecting the radium-barium salt to a process which will separate the radium from the barium. No strictly chemical process for effecting this separation is suitable, and practically a process of fractional crystallization of the chloride, bromide or hydroxide is used. It was found by Mme. Curie, for example, that radium-barium chloride, when allowed to crystallize from an aqueous solution, gives crystals containing a greater proportion of radium to barium than was contained in the original salt, or the salt left in solution in the mother liquor. Application of this fact in a process of fractional crystallization makes it possible to concentrate the radium in the "heads" and the barium in the "tails," resulting finally after hundreds of operations in the production of a few hundred milligrams of comparatively pure radium salt from the treatment of hundreds of kilos of the crude radium-barium salt as obtained from the ore.

There is probably a total of not more than a hundred and twenty grams of radium element in all the high-grade radium preparations in the whole world. Of this amount thirty grams have been prepared in the Radium Research Laboratory of the Standard Chemical Company during the five years that production has been under way. Other production in the United States, including the radium produced by the United States Bureau of Mines for the National Radium Institute, probably totals about fifteen grams, making the United States the producer, to date, of over a third of the word's radium supply. The present producing capacity of the Standard Chemical Company is 1.5 grams of radium element per month.

The greatest use for radium up to the present has been in the treatment of various growths, malignant and benign. Certain types of cancer respond readily to the action of the beta and gamma rays of radium (the more penetrating rays) and this same action also enables the medical man to give great relief in certain types of hopeless cancer, where medical science has heretofore been helpless. For these medical purposes the radium salt is used, not as a medicine but rather as a physical agent for the production of its characteristic rays. The radium, usually in the form of radium-barium sulphate, containing from 60 per cent. to 90 per cent. of pure radium sulphate, is either sealed hermetically in tiny thin-walled glass tubes or is spread in an enamel or varnish over the surface of a metallic plaque. In this way the radium salt is comparatively safe from loss and may be utilized continually with practically no depreciation, since the activity falls by only one per cent. in about twenty-five years.

A use of radium which has a considerable application, and which now is becoming of almost as great importance as the medical use, is in the production of the so-called permanently luminous compounds. This luminous material finds a wide range of use in all forms of dials and indicators that must be seen in darkness or semi-darkness.

Phosphorescent compounds are those which when exposed to suitable light are capable of storing up some of the energy, which is subsequently emitted in the form of light. A number of phosphorescent substances are known in which the luminescence persists for some time. Of these, the best known was the specially prepared calcium sulphide, which formed the base of Balmain's patented luminous paint. However, exposure to light is absolutely essential to the production of any degree of luminescence, and after such exposure this material emits a bluish light for only several hours. It was first used about 1877 on watch and clock dials, etc., but was practically discarded about twenty years ago, largely because of the necessity of first exposing the articles to light to render the luminous paint effective.

Early in this country, after the discovery of radium and other strongly radio-active substances, such as actinium, it was found that the rays of the radio-active substances were capable of exciting certain materials to the emission of visible light, even when not previously exposed to light—the necessary energy being supplied from the radio-active material. Of all known materials, prosphorescent zinc sulphide, so-called "Sidot's hexagonal blende," gives the greatest luminescence when exposed to the rays of radium, most of the light from the zinc sulphide being due to the numerous scintillations produced by the bombarding of the zinc sulphate crystals by the alpha rays.

Phosphorescent zinc sulphide consists of a specially prepared crystalline form of zinc sulphide which, when mixed with an amount of radium, continues to emit a greenish-yellow light, the intensity of the luminescence being dependent on the quality of the zinc sulphide and the proportion of radium used.

It has been known that many phosphorescent substances respond strongly to the action of ultra-violet rays and X-rays; however, the substances which are very luminescent under the action of these rays (such, for example, as Balmain's calcium sulphide, and native willemite) do not necessarily produce the brightest luminous mixtures when radium is added. To test the suitability of any given material, it is either necessary to add radium directly to the substance and compare the resulting luminosity with that of a good grade of zinc sulphide containing an equivalent amount of radium, or otherwise to bring alpha rays to play on the materials. We have found a polonium plate about twenty millimetres in diameter most useful, since this preparation emits an intense alpha radiation. With a suitable polonium plate a superficial luminescence can be obtained in zinc sulphide equal to that obtained by the addition of several hundred micrograms of radium per gram of zinc sulphide. By holding this plate over two adjacent specimens of zinc sulphide or other material, it is very easy to determine the relative values of their alpha-ray luminescence.

The luminescence of the zinc sulphide is roughly proportional to the radium content, falling off somewhat as increasingly large amounts of radium are added. Commercially luminous compound is in use containing from 25 to 300 micrograms (millionths of a gram) of radium element per gram of the mixture. Careful photometric tests have demonstrated that the rate of decay of the luminescence is proportional to the amount of radium, so that compounds which initially are brightest show the most rapid falling off in luminescence, while compounds containing proportionally less radium are not initially so brilliant, but have a longer effective life.

The decay in the luminescence of compounds in which radium is the exciting agent is not due to change in the radio-active substances, since it is well known that radium changes so slowy as to require 1,700 years for its half-decay—approximately 1/25th of one per cent. change taking pace in one year. The change in the zinc suphide, however, is not slow, which accounts for the diminishing luminescence of the compound with time. There are many points in connection with light emission from zinc sulphide that still remain to be explained. However, it may be said that the behavior of the substance indicates a capacity for sending out only a certain total amount of light, so that where a greater luminosity is excited by the use of a larger proportion of radium, the life of the zinc sulphide is proportionately shortened.

In the application of the luminous compound for its various uses it is mixed with a suitable vehicle, usually some form of clear, transparent varnish, the resulting thick paint being applied by means of a fine stiff-haired brush or a fine stylus. The difficulties to be overcome in this connection are dependent on the nature of the material and surface to be painted, as well as the nature of the surroundings. Paper, porcelain, mica, and metal dials of all sorts bearing figures and lines are now used. In the liquid-damped compasses, such as the aero-compasses, the card floats in alcohol, thus introducing a further requirement that the luminous paint resist the action of this solvent. The varnish most suitable for this purpose is yet to be found. For some instruments, such as aeroplane instruments, the requirements of luminosity are of most importance and outweigh the other considerations of cost and length of effective life. For such purposes the grades of luminous compound are prepared which give the highest initial luminosity, due to a larger proportion of radium, and having, consequentlly, a shorter effective life. For many other purposes, such as the use on marching compasses, wrist watches, etc., luminous compound of lower initial luminosity is recommended, and this material has the advantage of lower cost and longer life.

The chemistry of the radio-elements and the work on the constitution of the atom (a large number of the most important articles on this subject have appeared in the Philadelphia Magazine during the past several years. The article by Rutherford on "The Structure of the Atom" in vol. 27, p. 488, March, 1914, is very interesting for the general reader) which has grown out of the study of the radio-elements and their rays presents a far more interesting field than the technology of radium, particularly since the various phases of the treatment of radium ore, etc., cannot be detailed minutely. The atom, according to J. J. Thompson, can be considered as a series of concentric rings of electrons in rapid orbital motion about or within a sphere of positive electrification. Such an atom is capable of accounting for many of the properties of matter, both material and electrical. Rutherford more recently has modified this view of the atom and considers the sphere of positive electrification or nucleus of the atom as exceedingly minute in comparison with the dimensions of the atom. This view is the result of careful observations on the scattering or deviation of alpha rays from their paths in passing through matter, the assumption being that the very sharp bends in the path of the alpha ray indicate an approach of the alpha ray to the nucleus, causing the deviation. Mathematical calculations by Darwin for alpha rays in hydrogen demonstrate that the centres of the nuclei (the alpha ray is the nucleus of the helium atom) must approach to within 1.7×10^{-13} centimetres of each other. This view is confirmed also by experiments made by Marsden on the repulsion of the hydrogen nuclei by alpha rays. According to Rutherford, the hydrogen atom consists of one negative electron moving orbitally about the nucleus, which consists of a positive electron having a much smaller diameter than the negative electron. As is well known, the mass of the negative electron is about 1/1700 the mass of the hydrogen atom, so that the bulk of the mass of the hydrogen atom must reside in the nucleus, and this is accounted for on the basis of electro-magnetic mass by the fact that the diameter of the hydrogen nucleus is so much smaller than that of the negative electron. Alpha rays penetrating into a gas, such as hydrogen, move through a definite distance before they lose their kinetic energy and become ordinary helium atoms. This distance is called their range, and within its range the alpha ray is capable of producing such phenomena as ionization of gases, scintillation in zinc sulphide, etc., whereas at a distance greater than the range, these phenomena are not observed. Marsden has found that when the alpha rays from radium impinge into hydrogen gas there are the usual scintillations observed on a zinc sulphide screen due to the alpha rays; however, beyond the range of the alpha rays, some three or four times the distance to which the alpha rays could penetrate, there are still scintillations and these are attributed to the hydrogen nuclei which are set in rapid motion by collision with the alpha rays, the energy of the alpha ray being transferred to the hydrogen nucleus, and this having a smaller mass moves through the longer range.

[TO BE CONTINUED]

"Protactinium," a New Radio-Active Element

According to a note in the *Chemical Trade Journal* for June 29th, a new radio-active element of considerable emissive power has been detected in the residue from pitchblende, which forms the raw material employed as a source of radium. This residue was subjected to treatment which finally left undissolved only the members of the tantalum group; and this insoluble remainder showed a radiation, at first slight, but gradually increasing largely, which proceeded mainly from the evolution of actinium, and indicated the presence of the new element "protactinium." Experiments for the separation of the elements are to be undertaken. The period of semi-disintegration probably fluctuates between 1,200 and 18,000 years. The information is based on statements published in the *Munchner Neueste Nachrichten*.—*Nature.*

Lateral Deviation of Projectiles

K. H. Güldner, in the *Zeitschrift des Vereines deutscher Ingenieure* for August 11th and 18th, 1917, describes some investigations which he carried out to determine the lateral deviation of projectiles caused by the spin imparted to them by the rifling of a trench-mortar. The trench-mortar provides a suitable means of carrying out such tests as the motion of the projectile may be followed by the eye. Rifling with a right-handed twist may cause constant lateral deviation both to the right and left. Right or left deviation is the result of right or left precession, and is visible to the naked eye. Left precession with rifling having a right-handed twist can occur only after the maximum height of the trajectory has been passed if the center of action of the air-resistance lies behind the center of gravity of the shell. The precession on the ascending part of the trajectory is always greater than in the descending part.—*Nature.*

Tyu-on-yi, the earliest known communal dwelling in America

A section of the Canyon wall, showing blow-holes and cliff-dwellings

Lost City

The Forgotten Dwellings of a Forgotten People in New Mexico

By Charles d'Emery

Photographs copyright by E. M. Newman

With all the different means of transportation, this world has become a maze of highways and byways, more or less traveled. Beyond these, even a few miles beyond, there may lie treasures and sights that would bring us thousands of miles to see, if we but knew where to find them. When some one stumbles across one of these wonders, he may find it too awesome, too impressive in its grandeur to describe. No words are descriptive enough, no photographs realistic enough, to give someone else the feeling of sublime grandeur that we experience, when we first look down upon the vale of the Lost City.

We must experience the immensity of it, the magnificent heights and depths at our feet, a thousand feet of sheer wall in red, brown, white and yellow, and play of ever-changing sunlight and shadows. One must feel the solitude of those thousands of square miles of fantastic realities, seven thousand feet above the sea level, and capped with a dome of ethereal blue, before we can gage what our eye perceives.

At our feet is a canyon perhaps twelve miles in length, its greatest depth is two thousand feet, its width barely half a mile; a thousand feet below us lie what seem to be the lodges of some ancient amphitheatre. It is the first known Communal Dwelling of the pre-historic Cliff Dwellers of America.

It is barely forty miles from the city of Santa Fe, New Mexico, from where the trip can be made by auto, to the very brink of the canyon. It is one of the most inspiring and thrilling auto trips in the world.

Forty miles across the great Mesa, studded with millions of stunted cedars, grease wood bushes, vivid stretches of chamisa, crossing numerous arroyas, huge gashes in the surface of the plateaus, that were sometime or other swept with tearing torrents of water. The road is little more than two large ruts, and even these are indistinguishable at times.

After a gradual descent of many miles we arrive at Buckman, a couple of shantys guarding the bridge and the great sweep of the Rio Grande. After crossing the turbulent waters by means of the swaying wooden bridge, the aspect of the country changes, the grades become terrific, the road skirts the very edge of precipitous cliffs, that spread out before us a landscape of magnificent proportions, until from an altitude of over eight thousand feet above the sea level, we look down upon the winding river, no longer turbulent and rushing, that appears now as a glistening road of silver, and almost at our very feet a flimsy thread—the bridge that we had crossed an hour before.

Eight miles distant, forming our horizon, are the snow-clad peaks of the Sangre de Christo Range (meaning blood of Christ) from their appearance at sunset. Now in silver grey and blue a sharp contrast with the vast panorama of spotted mesa country before our eyes.

At the bend of the river are the beginning of the gigantic cliffs that form the huge chasm of the Rio Grande, two thousand feet high, a wedge-shaped monstrosity of volcanic rock and ash, as perpendicular as a plumb line.

All about us are the tell tales of ancient volcanic fire, when the continent was in the making, dazzling white ash, crimson trap, lava, all in strange formation and various stages of erosion.

Sometimes our road leads us through old forests of pine; three times we descend and ascend canyons hundreds of feet in depth, and heavily wooded, along zigzag trails that seem impossible, so dreadfully steep are the grades. All about us are the walls of centuries, with all the coloring of a kaleidoscope, a thousand scenes, each one a memory never to be forgotten.

From amid the pines we may look up to the cliff houses of these prehistoric canyon dwellers

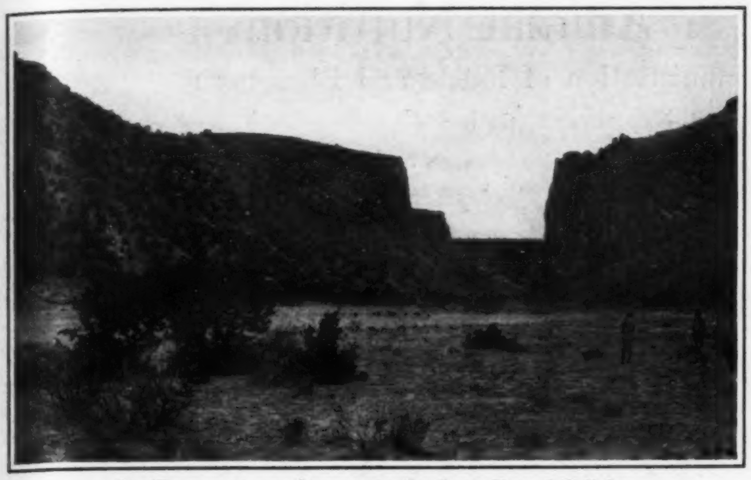
Late in the afternoon as the sun is beginning to tinge the red cliffs with a fiery glow, we arrive at the very edge of the canyon, generally called the Rito de los Frijoles, and Tyu-on-yi, the ancient and first known city of the Cochiti tribes, Pueblo Indians of the Southwest.

Even the most case-hardened tourist that flits from place to place without really seeing anything, will find that here is a power that will compel him to spend the night in the canyon. It is no hardship to do so, for his host is a retired judge, who has come to love every foot of the remarkable canyon, and who will be able to give those that are interested a wealth of information that has not yet been written in books. Mr. Abbot has erected comfortable tents, where one can enjoy all of the pleasures of the great outdoors, and at the same time enjoy meals that are a wonderful surprise, even to the most fastidious palate. Mr. Abbot is the Government Guardian of the canyon's historical relics.

With the dawn of day, and it is well worth while to rise early enough to see the dawn light up the deep recesses of the narow gorge, your guide will be ready to show you some of the wonders of these ancient habitations.

You are standing before gigantic walls, sheer for a thousand feet, parts of it are red and brown, other parts dazzling white, and almost the entire surface is honey-combed with thousands of volcanic blow holes that once upon a time belched forth the sulphur fumes and steam of the earth's core.

When the early dwellers of this continent first beheld these openings in the face of inaccessible cliffs, it must have occurred to them that here was the natural nucleus of homes that would be safe from attack, both from man and the possible giant beasts of the stone age, for using them as a center, he patiently enlarged them until they assumed livable proportions. All of them are more or less circular and from ten to fifteen feet in width. The doorways are small, one would have to crawl in on hands and knees, making it safe against surprise attack. The ceilings are vaulted and always have an opening that was used as a chimney. In some cases it is natural, and in others it has been con-



Devil's canyon, on the way to the Lost City of Frijoles

A close-up of the doorways and chimney openings

nected by an artficial tunnel to some natural vent in the honey-combed rock. Although the smoke of ancient fire places has obliterated much of the hieroglyphics upon the plastered walls, a careful study and removal of the top soot will reveal plainly many symbols of a race that was.

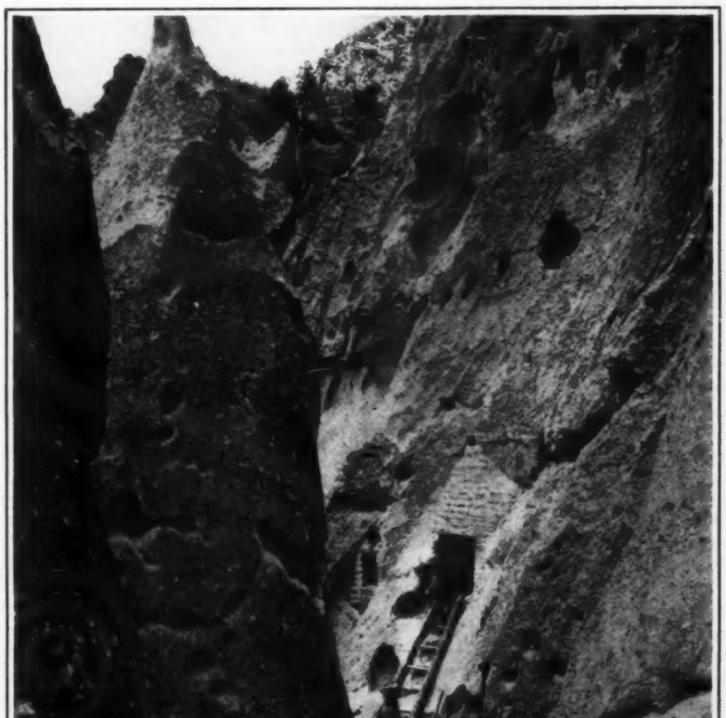
Some of these cliff dwellings are only the inner retreats of more pretentious houses built in front of them at the base of the cliffs.

These outer houses are built of rectangular bricks, probably made from powdered tufa; these bricks are cemented together, rafters being used to uphold the ceilings. Certain sections of the cliff still show mortises into which the rafters had been inserted, and proves beyond doubt that these dwellings were built in tiers three stories in height, probably in the form of steps, such as still used by the Acoman and the Taos Indians of to-day.

Centuries of time have dealt savagely with these outer buildings, for very little is left standing.

You may wander for hours, visiting thousands of these dwellings for it is said that there are about twenty thousand of them, but the most complete as well as the most impressive memorial of these ancient peoples is the great ceremonial cave or Kiva. Its situation itself is amazing. Two-thirds up in the face of the imposing wall, carved out of the solid rock, partly by nature, and partly by the hand of man, it appears as a gigantic Eyrie of some pre-historic monster.

It is accessible only by means of ladders and a toilsome climb among slippery walls of volcanic ash, but it is well worth the trouble to see the underground Council Chamber or Kiva, and to live for a moment among the Phantom Councils and rituals of an unknown past. For these blank walls and recesses, where communion was held with the Gods, will hold forever the mystery of Life and Love, that lived and died here, in a passing moment of Infinite Time.



Prehistoric mansions in the heart of the volcanic ash

Wind Circulation of the Globe

UNTIL some twenty years ago meteorology was regarded as an elementary science founded on theories so simple that they might be taken as self-evident. Thus the cyclone was looked upon as a warm column of rising air with spirally inflowing winds at its base; the anticyclone, conversely, contained a cold core of descending air. Now we know that the opposite is in reality the truth; the cyclone has a cold core, the anticyclone a warm one. Another theory of equal simplicity and perhaps of even greater antiquity explained the general circulation of winds around the globe. It was argued that solar heating made the equator very much warmer than the poles; therefore there must be a rising current at the equator, a poleward flow of air in the upper layers of the atmosphere, a descending current in polar regions, and an equatorial flow in the lower layers. To question the validity of such a theory would have been regarded as almost an impertinence.

In a recent paper Hildebrandsson has dealt in a comprehensive manner with this question of world circulation, avoiding preconceived theories, but collecting all available information on the subject. Incidentally he puts forward several very cogent reasons why the simple theory outlined above is untenable, though there can be few meteorologists of the present day who regard it at all seriously. The main surface currents have for a long time been fairly well known, and it is with the upper winds of the troposphere that the greater part of this paper is concerned. The chief sources of information are (1) cloud observations from the international network of stations which observe cloud motion, and (2) results of pilot-balloon and *ballon-sonde* ascents. The former afford the larger body of data, while the latter present more detailed information and provide valuable confirmation of the general conclusions otherwise arrived at.

The main general system of world currents is made up as follows: (1) Over the thermal equator there is a current from east to west at all heights, weak near the surface of the earth, but very strong in the upper layers of the atmosphere. (2) In the temperate zones the currents are from west to east. In the lower layers of the atmosphere the intermediate regions between these two current systems contain the tropical anticyclones and the trades, which blow from N. E. in the northern hemisphere, and from S. E. in the southern. In the upper layers the easterly wind over the equator veers in the northern hemisphere successively to S. E., S., and S. W. as one passes northward, thus turning into the well-known counter-trades. These feed the upper part of the tropical anticyclone from the equatorial side, while the polar side is similarly fed by a deviation of the main westerly current to N. W.

The above form the chief wind systems of equatorial and temperate latitudes. In arctic and antarctic regions data are more scanty, and the wind currents do not seem to fall into any such simple system in these parts of the globe. It is interesting to learn that the great monsoon currents, which have such an important influence on the meterology of many regions of the earth, are relatively shallow, being not more than 4 km. to 5 km. in depth. They must be regarded only as great perturbations in the general system of circulation outlined above. Similarly, the cyclones and anticyclones of temperate regions are phenomena of the lower layers, above which blow in general the undisturbed westerlies at great heights.

A valuable feature of the paper is the numerous tables, which set out the data obtained from different parts of the globe. Mention must also be made of two charts showing the upper wind currents which prevail above the North Atlantic "High" in summer and winter. It is unfortunate that practically no velocities are given, wind directions only being dealt with. The reasons for this are fairly obvious in the case of cloud data, but it would have added to the value of the discussion if in the tabulated pilot-balloon observations wind velocity had been given as well as direction. Throughout the paper directions are indicated by degrees from one of the cardinal points, but no uniform plan seems to be followed. There appears little justification for denoting a direction as N. 70° W. in one place, and W. 20° N. in another, to quote one example. It is desirable to point out that the references on pp. 12-17 to the plates at the end of the paper are mostly in error. These detail imperfections do not, however, appreciably detract from the great value of the paper as a comprehensive study of world air currents.—*Nature.*

Textile Fibers in Germany

IN the *Zeitschrift des Vereines deutscher Ingenieure* for October 5 last, Dr. G. Rohn discusses the question of German's textile requirements in the light of the feared economic boycott of that country by the Entente Powers, and briefly reviews what has already been accomplished in the way of finding substitutes. A certain amount of success has been attained in nettle cultivation. Although the yield of fibres from nettles is only 6 to 7 per cent. of the weight of the plant, the fibre has valuable properties, being very fine and smooth and strong. Since the war broke out some fifty processes for utilising nettle-fibres have been patented. It is thought that 1,000,000 hectares of lowlands could be planted with nettles, producing some 80,000 tons of fibres annually. The author also shows the progress made with wood-fibres, especially from the conifers. Experiments have been going on for some time with the view of extracting the fibres by chemical treatment, and success has rewarded the efforts of investigators in some directions. Developments have taken place, too, in the production of yarns from paper-stock, a number of companies having obtained licenses to work the Türck Co.'s patents. The method of obtaining yarn from paper itself is outlined, and it is said that this method of treating wood is expected to render valuable service to Germany in future.—*Nature.*

The Mineral Elements in Animal Nutrition*

With Special Reference to Source and Administration of Iodine and Phosphorus

E. B. Forbes, Ohio Agricultural Experiment Station

As agricultural scientists, our interest in the mineral elements lies in that larger intermediary metabolism between the soil and the sea which begins with the weathering of the rocks, includes the whole of plant and animal metabolism, and ends with the formation of new rocks. Throughout this vast sweep of chemical change the mineral elements occupy a unique and dominating position, entering in essential ways into every process and exerting an influence in metabolism entirely out of proportion to the amounts in which they are involved.

In a large and general way life may be regarded as a coordinated system of responses to electrical stimulation. The ions, and especially the inorganic ions, are the bearers of this electricity, and it is because of this fact that they are able to play a leading rôle in the direction of the whole process of metabolism. Gustav Mann says, "So-called pure ash-free proteids are chemically inert and in the true sense of the word, dead bodies. What puts life into them is the presence of electrolytes."

This, then, is the basis of our interest. More specifically, this subject concerns us because the mineral elements of soil fertility—of plant nutrition—supply the mineral nutrients of animals. All of those conditions of growth of plants, as to soil fertility, heat, light, and moisture, which affect their mineral content affect the food value of these products for animals. Similarly all of those processes of treatment of foods, as to conditions of harvesting, storage, manufacture, preservation, and preparation which affect their mineral content have a bearing on the nutrition of animals. Further, the almost unlimited freedom of choice of foods afforded by our markets and our prosperity, a freedom which may profoundly affect the mineral content of the diet, furnishes a basis of interest and an obligation to understand. Finally, the mineral requirements of men and animals in their various conditions and stages of life, growth, health, and activity differ greatly in such ways as to demand our attention, since the whole range of success and profit in practical animal nutrition lies close, and ever closer, to maximum possibilities.

As this subject relates to stock feeding, we find that modern tendencies give it a special importance that it had not in times past. The forced feeding of our early-maturing meat animals and the selective improvement of our poultry and our dairy cows for greater productive capacity call for a higher percentage of mineral nutrients in foodstuffs than was necessary in the old days of less intense production. The requirement of mineral nutrients for mere maintenance is slight in amount, compared with the requirement for the production of flesh, eggs, and milk; hence, the more efficient the producer, the higher must be the ash content of the food.

My own investigations in this field consist of studies of the chemistry of foods, and metabolism experiments with swine and milch cows. I shall review briefly some of the conclusions from this program of work.

Our studies on foods comprise a series of complete ash analyses, with computations of the elements to normal solutions, these data being considered in relation to the balance of base and acid in the organism; also a study of the mineral nutrients of bluegrass, and factors which affect the quantities present; and a study of the iodine content of foods in relation to the prevalence of goiter.

It is an established fact of animal physiology that the vital processes require the maintenance of a state of approximate neutrality in the blood and lymph. Henderson has done much to show how this balance of acid and base is maintained by self-adjusting chemical and excretory equilibria. The mineral elements of the food contribute to one side or the other of this base and acid balance; and the extent and nature of this contribution are matters of importance in relation to acid intoxication, even though this condition is not commonly caused by the food. Our extensive series of ash analyses show that cereals, meats, and eggs have acid ash, while fruits, roughages, vegetables, milk, and most legumes have alkaline ash. While healthy animals have means of neutralizing all ordinary excesses of acid in the food it is safest that the bases should predominate, since we do not know that the neutralization of acids is always accomplished without expense, and since in any such physiological state as causes acid intoxication (and there are many such) an excess of mineral acid to mineral base in the food is undoubtedly a matter of positive disadvantage.

Acid intoxication is met with most commonly in the feeding of infants and older children suffering from fever, undernourishment, or indigestion especially involving the fats of the food. In these cases the use of whey in the diet furnishes mineral nutrients of value; and the administration of sodium citrate (1 to 2 grains per ounce of milk) is also a beneficial practise in that it furnishes a readily oxidizable alkali salt. The presence of this citrate is also favorable to the digestion of casein. Many a so-called idiosyncrasy against milk protein has disappeared under the influence of sodium citrate and a low-fat diet.

Our study of the mineral nutrients of bluegrass touches a subject of deep significance. Through its habit of growth grass is the great conserving factor in agriculture. As the basic requirement of livestock breeding it makes for all the benefits of this system of farming, especially the maintenance of the fertility of the land and the maintenance upon the land of the presence of the family of the owner. The permanent prosperity of an agricultural community is assured by the excellence of its grass lands.

Now we have shown that the mineral nutrients of bluegrass vary more than 100 per cent. in accord with the fertility of the soil. The skeletons of growing animals respond readily to the mineral nutrients of the food. There is no definite upper limit of phosphate deposit in the bones. The quality of the grass must affect the quality of the bones; and strength and soundness of bone favor long-sustained efficiency. Probably the greatest strain to which the bones of animals are subjected is in the service of our large, early-maturing horses on hard-surfaced roads and pavements. The most famous horse-breeding center of the United States is a region of limestone soils and luxuriant bluegrass which our analyses show to be unusually rich in bone food. We have always bowed while the Kentuckian asserts that his state produces the most beautiful women and the finest horses in the world, and now we know that in so far as these claims depend upon a superior quality of bluegrass they rest on a substantial basis of fact.

It is also true that in many localities in this country, on impoverished soils, we find horses and cattle suffering from malnutrition of the bones. This ailment is most common during periods of rapid growth or milk production, especially during and immediately after seasons of drouth and restricted food supply. This condition responds readily to treatment with calcium phosphate.

Among the several mineral elements present in foods in minute quantities especial interest attaches to iodine, because of its importance in metabolism. The only tissue in the bodies of vertebrate animals which contains iodine in apparently essential relations is the thyroid gland. The iodine content of the thyroid may be increased by the administration of iodine; one of the active principles of the thyroid is its iodine-containing constituent; and goiter in certain stages responds favorably to iodine treatment. Further, there is a marked and continuous local prevalence of goiter in many regions. These facts furnish sufficient basis for our interest in the iodine content of foods.

In our study iodine was estimated in 927 samples of animal and vegetable products. These products were in part common foods from the market; a large number were from the fertilizer plots of the experiment stations of the country; others were from regions of interest because of the extreme prevalence or rarity of goiter; still others were products from an extensive metabolism experiment with milch cows. The method of estimation used was accurate to three-millionths of a gram of iodine.

About one food sample in five contained iodine. The amounts present were usually too small for expression otherwise than as traces. In 18 samples each of cow's milk, urine, and feces no iodine was found. Iodine was found in considerable quantity only in agar and in Irish moss (from which *blanc mange* is made). No other seaweeds were examined. No iodine was found in 16 samples of table salt or in any one of seven kinds of nuts. It is very rarely present in spices and condiments.

Among the animal products the only one containing iodine in more than traces was hair and hoof, from swine, a sample prepared in the course of a complete chemical accounting for the bodies of some experimental subjects. Traces were found in butter, in eggs, and in several kinds (but by no means in all samples examined) of meat, fish, and crustacea (shrimp and lobster).

Among the cereals iodine was found as an uncommon constituent, usually in traces only. None of the fruits contained more than the smallest recognizable traces of iodine, and very few contained even so much.

Among the garden vegetables and root crops beets rather commonly contained traces of iodine (9 samples out of 25), and in one case a larger amount. Two out of three samples of cucumber contained iodine; also one out of three samples of celery. Iodine was found in single samples of endive, kohl rabi and lettuce. Among onions five samples out of 15 contained iodine, and in parsnips two out of six. Six samples of potatoes out of 21 contained iodine; it was also found in spinach and in rhubarb. We found iodine in one sample of turnips out of 11, but none in tomatoes, pumpkin and squash.

Of the hays, silage, and forage crops about one sample in four contained iodine. Among leguminous seeds iodine was found in 11 samples out of 32, more commonly among beans, peas, and cowpeas than among soy beans.

The manufactured foods, and milling and manufactory by-products contained iodine in 13 samples out of 25; of those containing iodine 10 were made from cereals. The offal portions of the grains are apparently richer in iodine than the more starchy parts.

The more important sources of iodine in the human dietary, then, are the garden vegetables, though some is also found in the cereal foods and in several foods of animal origin, mostly of the sorts less commonly used.

Among the foods used by livestock the more important sources of iodine are the hay, silage, and forage crops, and also the milling and manufactory by-products, comparatively little being found in the natural grain foods.

No consistent or orderly geographic distribution of iodine in foods was revealed; nor were there noticeable effects of the type of soil or method of fertilization on the iodine content of foods. We found nothing characteristic in the iodine content of foods from regions where goiter was especially prevalent. The iodine content of samples of the same crop from different plots of the same field sometimes varied greatly.

The general conclusion from this study was that iodine is a comparatively unusual food constituent and that its presence is commonly accidental in the sense of standing in no essential relation to the growth of the food products. Variations in the iodine content of foods were not successfully correlated with any associated conditions.

It is possible that the total iodine requirement of the organism is gleaned from foods containing so little of this element that its presence would escape detection by our best methods of estimation. It is also possible that the iodine content of the drinking water is of greater importance in relation to the cause of goiter than is the iodine content of the foods.

The general effect of this study is to direct us elsewhere, especially toward the metabolism of the organism, in our search for the cause of goiter.

We shall now consider the results of mineral metabolism studies with swine. This subject is of especial importance in this connection because no other animals are so grievously sinned against in the provision of their mineral requirements. Several factors unite in bringing about this state of affairs. Among these are the extreme rapidity of growth of improved hogs, the great weight of fat carried, the early age at which reproduction and lactation occur, the custom of rearing hogs in comparatively close confinement, and the feeding of too little else than corn. This combination of conditions often results in the crippling of hogs during shipment to market, the breaking down of sows while suckling pigs, and a general abbreviation of the period of usefulness of breeding stock.

Our studies with swine have been on the specific effects of corn and of supplements to corn, and a comparison of the nutritive values of several pure compounds of phosphorus, these studies having been con-

*A lecture delivered before the Washington Academy of Sciences; from the Journal of the Society.

ducted by feeding, slaughter, and carcass analysis experiments. The specific effects of corn as an only food for growing swine were shown to be, in general, a retarded development of proteid and bony tissues and an over-development of fatty tissue. This results in the production of fine-boned, poorly muscled, undersized, and over-fat animals, which reach their limit of growth prematurely and which are characterized by less than normal breeding capacity. Impaired fecundity seems to result from discouragement of proteid increase generally and from the lessened circulation of blood in the female reproductive organs, this last being caused by pressure of the excessive amounts of internal fat which accumulate about these parts. With hogs fed on corn alone, the bones, muscles, liver, kidneys, lungs, heart, and spleen all compose an abnormally small proportion of the increase in weight, and fat composes an abnormally large part of the increase. The bones are lacking both in density, as indicated by ash content, and in breaking strength.

Many of the specific effects of corn as an only food for growing animals are due to its insufficient content of protein and to the incomplete character of its largest protein constituent, zein. The only effects which can safely be attributed to the mineral constituents of corn are those affecting the skeleton.

In one experiment corn alone was compared with corn supplemented by soy beans, linseed oilmeal, wheat middlings, tankage, and skim milk. The rations of corn alone and of corn and soy beans produced the least bone. The rations of corn supplemented by tankage and skim milk produced the most bone. Rations of cereals or other seeds will not produce normal growth of bone in swine. These facts depend directly on the content of these foods in the chemical elements which compose bone.

The proportion of calcium, magnesium, and phosphorus in the bones tends strongly to remain constant, but may be modified to a certain extent by the limitations of the food. The amounts of these elements in the bone, however, are susceptible of much greater modification through the composition of the food. Bone meal, when added to a ration which is low in calcium and phosphorus, will greatly increase the ash and strength of the bones. The change in external dimensions is slight, but increase in the density and thickness of the walls of the bones may proceed indefinitely. The readiness with which minerals may be deposited in the bones, the lack of a definite upper limit of such deposit, and the readiness with which these minerals may be withdrawn constitute the skeleton a true store of mineral nutriment.

We have not been able by any method of feeding, in confinement, to produce bones as strong as are the bones of pigs raised on pasture. It seems quite possible that exercise, as well as food, has its effect to strengthen the bones through inducing an added avidity of the osteogenic cells for bone salts.

In a metabolism investigation with swine five pigs, all from the same litter, were taken through eight 10-day collection periods separated by 7-day intervals. The feeds, as in the experiment last mentioned, were corn alone, compared with corn supplemented by soy beans, linseed oilmeal, wheat middlings, tankage, and skim milk; also one ration was composed of rice polish and wheat bran. The pigs grew normally, and stored nitrogen and sulphur liberally in each period, though, naturally, less of these elements was stored from the ration of corn alone than from rations containing more protein.

Potassium was stored in all periods except one; strange to say, the ration composed of rice polish and wheat bran was the one in which this element was supplied in the greatest amount. Animals have no means of storage of large amounts of potassium salts. The large excretion of potassium on this maximum intake may be considered as a protective measure. In this case the negative balance did not signify insufficiency.

Sodium and chlorine balances were much affected by the water drunk. The intake of these elements would have been insufficient had not the amounts present in the foods been supplemented by the use of salt. Those individuals which drank the least water retained the most sodium and chlorine.

The more significant results of this experiment have to do with calcium, magnesium, and phosphorus. These elements are closely associated in metabolism. In the two rations where the corn was supplemented by skim milk and by tankage (containing a considerable amount of bone scrap) the calcium retention was 9 to 10 times as great as in any of the rations composed of grains and other seeds and seed products. On rations of corn alone, of corn and soy beans, and of rice polish and wheat bran the calcium balances were negative; that is, more calcium was given off in excreta than was received in the food. This result emphasizes the fact that the cereals are very poor bone-foods. The negative calcium balances from the ration of corn and soy beans call attention to the fact that the phenomenally high calcium content of legumes is true of the plants as a whole and not of the seeds. This emphasizes the value of leguminous roughage as bone-food.

In these rations the retention of calcium was closely related to the intake of the same, and not appreciably affected by the excess of mineral acid. Physiologically, calcium and magnesium are balanced opposites. An excess of magnesium in the blood causes a counteractive liberation of calcium; but the proportion of these elements in the blood does not follow closely their proportions in the food, and we did not find the calcium retention to be limited by an excess of magnesium in the food except perhaps in one ration, composed of rice polish and wheat bran and containing 12 times as much magnesium as calcium. In this case the great excess of magnesium seems to have been unfavorable to calcium retention. This proportion seems not to be a matter of practical importance in ordinary rations.

The phosphorus balances in these rations were always positive, but the retention was much below normal on the ration of corn alone. The more important reason for this deficient storage of phosphorus from corn was the lack of calcium, since calcium was more deficient than phosphorus, and since neither can be stored in large quantity except as they are combined in the calcium phosphate of the bones.

There were large excesses of inorganic acid elements in these rations. They were neutralized by ammonia. We observed no evidence of acid intoxication. We do not have knowledge of any such prevalence of acid intoxication in domestic animals as that with which we are familiar in human beings.

The urinary ammonia excretion was found to vary in the same order with the excess acid of the ration, providing that the protein remained about the same in amount; but any considerable increase in the food protein also increased the urinary ammonia.

Another series of experiments with swine dealt with phosphorus metabolism. Considering the phosphorus compounds of plants and animals the most obvious distinction among the various groups is that in certain of these the phosphorus is organically combined, as part of the living tissue, while in others it is present as simple salts of the mineral bases, either in solution, or deposited in supporting structures (in animals), or as crystals or incrustations (in plants). Our object was to learn whether organic and inorganic phosphorus in the food could serve equally well all of the purposes for which the animal needs phosphorus.

Our practical interest in the problem is due largely to the relative availability of organic and inorganic phosphorus. Inorganic phosphorus may be had in unlimited quantities as prepared from old bones and rock phosphate, and the inorganic phosphorus content of foods may be greatly increased by the fertilization of the soils upon which they are grown. Organic phosphorus we get from such expensive foods as milk, eggs, and beef, and from cereals. The organic phosphorus content of foods is not susceptible of important modification by treatment of the soil.

In this study we included orthophosphates because of their cheapness and availability, hypophosphites because they are so much used in human medicine, phytin as an especially abundant phosphorus storage compound of vegetable foods, glycerophosphates because of their relation to lacithin, a universal cell constituent, and nucleic acid because it is found in the nuclei of all cells.

These compounds in the pure form were added to a low-phosphorus basal ration in amounts contributing equal quantities of phosphorus. The subjects were growing pigs. Results were obtained by the method of the metabolism experiment and by the analysis of the carcasses of the animals.

It would seem, at first glance, that this problem should readily yield to careful experimental investigation, but intimate acquaintance has shown it to be extremely complicated and difficult. Many investigators have studied it, and the problem has been finally answered many times but in many different ways. If this problem is settled, in the end, as many such subjects of controversy have been, most of those who have studied it will be at first surprised, then chagrined, and then gratified that so much of truth was found on both sides of the discussion. Recent evidence has been mostly with those who believe that inorganic phosphorus can serve all of the purposes for which animals need phosphorus, but there is still much uncontroverted evidence that there are differences in the metabolism of some organic and inorganic phosphoric compounds which imply at least a greater usefulness of some organic compounds for some purposes with some animals.

In our work orthophosphates, glycerophosphates, hypophosphites and yeast nucleic acid, when added in the pure form to rations which are low in phosphorus but capable of maintaining phosphorus equilibrium, were all to some extent absorbed and retained.

Prominent differences were observed in the tolerance of the pigs for these pure phosphorus compounds. The limit of tolerance for glycerophosphates was not reached in any of our tests, but the other compounds were not so well taken. These drugs, when taken into the alimentary tract in quantity, in readily soluble condition, produced marked specific therapeutic effects which were, at least to a large extent, unrelated to fundamental nutritive values, and were likewise different from the effects of the same compounds as occurring in their natural physical and chemical relationships in foods. It is, therefore, impossible to state, from investigations of this sort, on pure compounds, what may be their nutritive values in common foods.

That the particular organic compounds used in this investigation (nucleic acid, phytin, and glycerophosphates) have nutritive values, to growing swine, superior to simple inorganic phosphates was not shown. No fundamental differences in the methods of usefulness of the phosphorus compounds studied were established, though, under our experimental conditions, they differed greatly in the extent of their usefulness; for instance, glycerophosphates were acceptable and useful in large quantities, the limit of which was not reached in our work; orthophosphates were distinctly less acceptable; phytin and nucleic acid were tolerated in still smaller amounts; while hypophosphites were the least acceptable of all. Still, so far as our results indicate, these compounds were all useful in the same way.

No basis was discovered for a differentiation between the nutritive values of organic and inorganic phosphorus compounds generally. It should be borne in mind, however, that no representatives of the two classes, phosphoproteins and lecithins, were included in this investigation, and results obtained under conditions of such rigid experimental control may not accurately represent the facts under optimum, normal conditions of life. These results are not considered to controvert evidence as to specific therapeutic effects of these phosphorus compounds in relations other than those considered in this study.

Even granting the debated superior nutritive value of organic or inorganic compounds of phosphorus, however, it is undoubtedly a fact that the organic phosphorus content of the animal body is a very small part of the total phosphorus, and as certainly true that a very much larger proportion of organic to inorganic phosphorus prevails in the diet of all amnivora and herbivora than in the bodies of these animals; and as for carnivora, the consumption of flesh and bones together would give them approximately the same proportion of organic to inorganic phosphorus in the diet as in their own bodies. It would seem, therefore, that for purposes of growth, the usual diet of animals must contain a sufficiently large proportion of organic to inorganic phosphorus. In this relation, then, the important consideration is simply one of the total phosphorus of the ration, and any such supplemental phosphorus as is to be added to the diet of the healthy, growing animal may be added as inorganic phosphate.

The amount of phosphorus which an animal will tolerate, when added to the ration in readily soluble form, is definitely limited at an amount much less than will be acceptable in its natural relationships in foods.

It seems unlikely that, with grown or growing animals, any ration composed from natural foods, and supplying the nitrogen requirement, will fail to furnish enough total phosphorus to maintain phosphorus equilibrium. That many such rations are lacking in the amount of phosphorus essential to maximum retention and growth, however, is as certainly true.

The results of our experiments indicate that the possibility of influencing, to a practical extent, the relative development of tissues and organs of livestock by the addition of isolated compounds of phosphorus to the ration is probably limited to the density and strength of the bones; but this is not saying that we may not be able by the use of these same compounds profoundly to influence physiological functions.

Throughout these studies of the influence of foods upon the nutrition of swine numerous effects of the mineral constituents of the rations on minor details of qualitative composition of the tissues have been noted, but the importance of such effects, as related to the functions of the parts, has not been demonstrated.

Our latest study in mineral metabolism was with

(*Continued on page 224*)

A Scientific Coin Problem

How Some Mysterious Numerical Effects Can Be Produced

By Theodore L. De Land

In the accompanying design (Fig. 2) you will observe fifty-six circles, each the size of a one cent coin. On each circle will be found four playing cards, the entire lot forming a combination that would be impossible for the human brain to remember. You can however place five one cent coins in any section of the design, setting them according to either arrangement shown in Fig. 3 and perform an apparently impossible miracle.

Request some one to place the five coins at any part of the design just so they form a combination like either one shown. You are out of the room while this is being done and without going through any mental calculation you can instantly name the total number of spots on the cards under the five coins. Strange as it may seem the result will invariably be 110 with either of the combinations in any section of the design.

Another good effect is to take six coins and have them placed in a straight line adjoining one another, in any part of the design, either vertical, horizontal or perpendicular. You are to name the number of spots on the cards under the six coins. To do this count from either end cent in a straight line in any direction to the FIFTH circle from this cent. Quickly total the number of spots on the four cards on this circle and to this total add 110. The grand total will be identical with the number of spots on the cards under the six cents.

A one cent coin placed on any circle also gives you a chance to demonstrate a peculiar effect. Count in any direction to the FIFTH circle from the cent and on this circle will be found the identical cards under the cent.

The method of laying out the design is simple enough.

First a square is formed composed of one hundred units, each represented by one of the first twenty-five letters from the alphabet. Each letter appears four times, being so arranged that the repeated letters are five points apart, the four forming a square, as shown in Fig. 1. Commencing at A the letters are given numbers in consecutive order beginning at 10 and ending at Y with 34. The object in commencing at 10 is that the lowest number formed by the pips on four different playing cards is 10. We have then A = 10, B = 11, C = 12, D = 13, E = 14, F = 15, G = 16, H = 17, I = 18, J = 19, K = 20, L = 21, M = 22, N = 23, O = 24, P = 25, Q = 26, R = 27, S = 28, T = 29, U = 30, V = 31, W = 32, X = 33, Y = 34

At one glance it is a self evident fact that any five consecutive letters taken either vertical, horizontal or on the diagonal form an equation. For example commence at X in the top row at R at the bottom:

$$X + K + C + T + G = R + J + V + N + A = 110$$

The playing cards are placed just so each circle is represented by cards whose total spots equal the required number.

If all of the twenty-five letters are used in certain series of five each, you get various combinations but each totals 110. Samples are

$$A + H + O + V + S = 110$$
$$B + I + K + W + T = 110$$
$$C + J + L + X + P = 110$$
$$D + F + M + Y + Q = 110$$
$$E + G + N + U + R = 110$$

and the letters are so placed that either of the patterns of Fig. 3, placed anywhere on Fig. 2, will cover one of these combinations—and that is all there is to it.

X	K	C	T	G	X	K	C	T	G
E	Q	I	U	M	E	Q	I	U	M
F	W	O	B	S	F	W	O	B	S
L	D	P	H	Y	L	D	P	H	Y
R	J	V	N	A	R	J	V	N	A
X	K	C	T	G	X	K	C	T	G
E	Q	I	U	M	E	Q	I	U	M
F	W	O	B	S	F	W	O	B	S
L	D	P	H	Y	L	D	P	H	Y
R	J	V	N	A	R	J	V	N	A

Fig. 1—The arrangement of the circles

Another peculiar effect is demonstrated by taking seven coins and forming a cross at any place in the table, as for instance:

Y
NAR
G
M
S

By making an equation of the respective letters in the cross and eliminating like members you get in every case a result similar to the following:

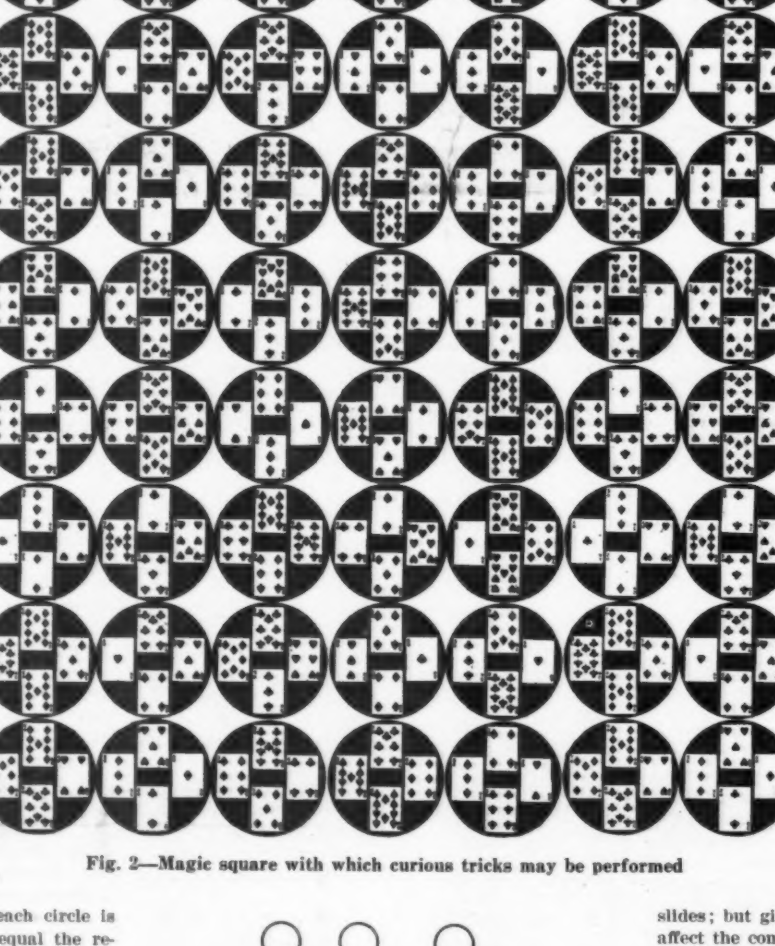


Fig. 2—Magic square with which curious tricks may be performed

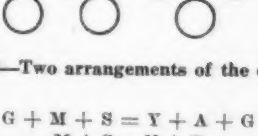


Fig. 3—Two arrangements of the coins

$$Y + A + G + M + S = Y + A + G + N + R$$
$$M + S = N + R$$
$$22 + 28 = 23 + 27$$
$$50 = 50$$

It follows that the lower two coins forming a cross cover the same number of spots as those covered by the two extreme coins forming the cross section.

Any person interested in mathematics will soon discover a vast number of combinations of most peculiar construction made possible with this design.

Hints for Photographers from Motion Pictures

The ordinary portrait or commercial photographer might very profitably pay more attention to the various technical hints deducible from motion films. Many valuable lessons may be learned in this way, and applied to the particular work of the individual.

What first strikes one when viewing film pictures on the screen is their superb definition, after such an enormous degree of enlargement. The ratio is approximately nine times as great as an announcement or title lantern slide projected to the same size, yet in how many cases is the latter noticed to be inferior in definition to the motion film. This fact is the more remarkable when it is remembered that the positive cinematograph film is printed by contact from the negative, the two being run rapidly past an exposure aperture, usually with intermittent stoppages, while the lantern slides are, sometimes at least, made by reduction. It speaks volumes for the delicate precision and exactitude of the cinema printer mechanism, and for the patient care bestowed on every stage of the work. Would that the same standard of rigidity and accuracy obtained in ordinary photographic apparatus, and that all camera craftsmen were as free from slipshod ways!

The reasons for the generally better definition of cinema films as compared with lantern slides will repay inquiry. Undoubtedly the chief is the very short focus of the taking lens used on the motion-picture camera, generally between 2 ins. and 3 ins. Not only does the shorter focus mean far greater depth of definition, but it is often overlooked that the latter is also equivalent to a smaller circle of least confusion. The same moral is constantly being discovered by owners of vestpocket cameras—namely, that the tiny negative made with a good-class lens of short focus will actually enlarge further and give better results than a bigger negative obtained in a larger camera with a relatively long-focus lens.

Yet another point is that the lantern slide, as often as not, is made from a negative secured with a rapid rectilinear lens, while the cinematograph taking lens is almost always an anastigmat. It has of late been confidently affirmed by some workers that one lens will, in practice, equal the performance of the other. To such a comparative test, by making transparencies and projecting to a fair size on the screen, is recommended as a clear proof to the contrary. To be strictly just, it must be remembered that the cinema projection objective is usually of a higher grade than that employed for showing lantern slides; but given good focussing, this should not much affect the comparison.

A further fact which will bear pondering over is the excellent perspective and absence of what is conveniently, but incorrectly called distortion in the majority of cinema films. Studio photographers are apt to grumble when condemned to use a lens of say, from 4 in. to 6 ins. focus in a small space; yet the cinematographer gets admirable portraits with still shorter foci. The explanation, of course, is the much smaller picture, for even with a 2-in. lens the focus is nearly twice the diagonal of the film image. Here is a self-evident and serviceable hint for the man who cannot obtain a decent size studio—to use a very short-focus lens, take only small negatives and enlarge from them instead of printing by contact. One might do worse than actually employ a motion-picture camera for the purpose.—A. Lockett, in *The British Journal of Photography.*

Analysis of the Mechanism of Speech

The impetus which recent events have given to the study of spoken languages has brought with it a renewed interest in the scientific analysis of the mechanism of speech. He who wishes to learn how to speak a foreign language must necessarily devote much of his time to the acquisition of the pronunciation, and he will most easily learn to become proficient at this difficult art if he can ascertain precisely what he has to do with his speech-organs in order to speak

Fig. 1—A Marey tambour. MM, the membrane; S, the style

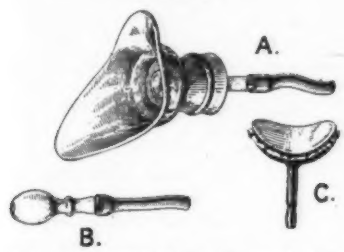


Fig. 2—A, mouthpiece; B, nasal olive; C, larynx capsule

correctly. The need for accurate information about speech movements has led to the development of that branch of science known as experimental phonetics—the branch of science which has for its object the accurate analysis of speech by mechanical means.

Among the numerous instruments which have been devised for speech analysis there is one of particular importance, known as the phonetic kymograph, and it is the object of this article to give a brief description of the nature and use of this apparatus.

The phonetic kymograph is essentially an application of the Marey tambour to linguistic purposes. The principle of this tambour is well known, and it is not necessary to describe it in detail. It will be sufficient to recall that it is a mechanism by which vibrating air is communicated to elastic membrane, and the vibrations of this membrane are in turn communicated to a very light needle or style (Fig. 1). The vibrations of the style are generally recorded on a revolving drum covered with smoked paper or some similar contrivance. Tambours may be of various sizes and materials. A very useful type is one in which the membrane is made of perished rubber, and measures 3 cm. in diameter.

Air vibrations set up by speech may be communicated to the tambour in three principal ways: (1) from the mouth (2) from the nose, (3) from the outside of the larynx. A rubber tube is attached to the tambour, and at the end of this tube is fitted (A) a mouthpiece (into which the observer speaks), or (B) a nasal olive (which fits into one nostril), or (C) a "larynx capsule" (which is pressed firmly against the outside of the larynx). These appliances are shown in Fig. 2.

The complete apparatus is shown in Fig. 3, which is an illustration of a small portable kymograph. The diagrams in this article were made on the large kymograph in the laboratory of experimental phonetics at University College, London; the cylinder of this machine has a circumference of one meter and a maximum surface speed of 70 cm. per second.

The most useful single tracings that can be made on the phonetic kymograph are those which result from speaking into the mouthpiece. More detailed information may, however, often be obtained by taking nose and mouth tracings, or mouth and larynx tracings simultaneously, or by taking tracings of all three kinds at the same time.

The accompanying illustrations show the nature of kymographic tracings and the deductions which can be made from them. Fig. 4 shows a mouth-tracing of the English word *potato*.[1] The horizontal parts of the line show the places where no air issues from the mouth, *i. e.*, the "stops" of the consonants, *p*, *t*, and *t*. The three steep rises in the line mark the explosions of these consonants. The small waves are caused by the air set in vibration by the vocal chords when "voice" is produced; in this diagram they represent the vowels. The regular wavy line figuring in this and other illustrations is a time-measurer showing hundredths of a second.

Various features of pronunciation may be studied from such a tracing as this. Such are: (1) the extent of aspiration of the explosive consonants (shown by the distances between the vertical lines 1 and 2, 4 and 5, 7 and 8); (2) the lengths of the vowels (shown by the distances between the vertical lines 2 and 3, 5 and 6, 8 and 9). The variations in the pitch of the voice may also be calculated to any degree of accuracy by measuring the voice vibrations in successive small intervals.

Fig. 5 illustrates the variations in length which English vowels undergo under certain conditions. The first four tracings show variations in the length of the English sound of *ee* as exhibited in the words *bee*, *bead*, *beat*, and the remaining three tracings show similar variations in the length of the so-called "short *i*" in the words *bid*, *bin*, *bit*. It will be seen that the vowels in *bean* and *beat* differ from that in *bead* in somewhat the same manner as the vowels in *bin* and *bit* differ from that in *bid*. It will also be observed that the so-called "short" vowel in *bid* is just about the same length as the so-called "long" vowel in *beat*. (Ignorance of the fact that the vowels in words like *beat*, *late*, are much shorter than those in *bead*, *laid*, is the cause of noticeable mispronunciation on the part of many foreigners.)

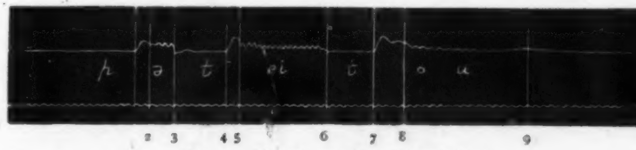


Fig. 4—Mouth-tracing of potato

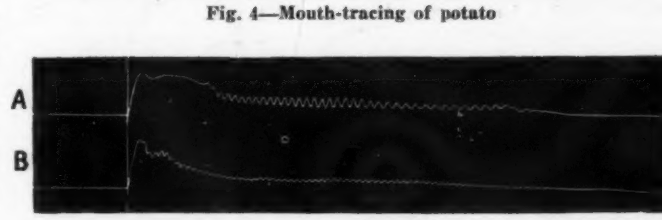


Fig. 6—A, mouth-tracing of play as said by the writer; B, mouth-tracing of the same word mispronounced by a Flemish-speaking Belgian

[1]The lettering appearing in this and other diagrams is a phonetic transcription of the pronunciation (International Phonetic system).

Fig. 6 shows (A) a mouth-tracing of the word *play* said by the writer, (B) a mouth-tracing of the same word said by a Flemish-speaking Belgian with a bad accent. It will be noticed that the Belgian mispronounced the *l* by making it completely voiced; in normal English this *l* is partially devocalised, *i. e.*, the vibration of the vocal chords does not begin until an appreciable time after the explosion of the *p*.

Fig. 7 is a record of *good morning* (as said on parting), in which tracings of the nose, mouth, larynx, and a time-measurer have been taken simultaneously. The points at which the various sounds begin and end

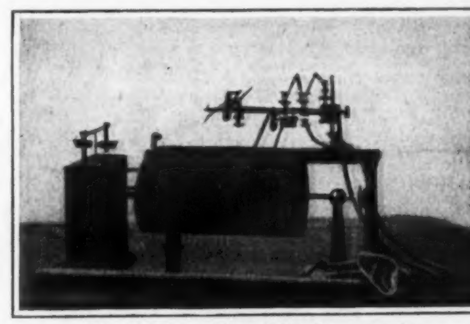


Fig. 3—A small portable kymograph

are clearly seen from the nose and mouth tracings. (This is where kymographic tracings have an advantage over enlargements of talking-machine records.) The distances between the vertical lines show the lengths of the various sounds. From the nose-tracings we may gather information as to the extent to which nasal consonants exert a nasalising influence on neighboring vowels. The larynx-tracing allows vibration-waves throughout, since every sound is voiced; this would be the most convenient curve to use for the purpose of calculating pitch.

Fig. 8 shows mouth-tracings of the English *buckle* and the French *boucle*. Two important differences will be noticed in regard to the consonants: (A) the English *l* is voiced, whereas the French *l* is not; (B) in the French word the *k*-sound is held on about twice as long as it is in the English word. The smallness of the voice-waves in the French word is due to the fact that the record is of a lady's voice.

The above short account of the phonetic kymograph will give some idea of the scope of the apparatus. It will be seen that the instrument is chiefly useful (1) for detecting the presence or absence of voice, (2) for detecting the presence or absence of nasality, (3) for measuring the lengths of sounds, and (4) for calculating the pitch of the voice. Daniel Jones, in *Nature*.

Digestibility of Artificially Dried Feed

Naturally dried fodders, such as hay, are but slightly less digestible and assimilable than freshly mown grass, but artificial drying produces considerable changes; loss of digestibility in this case is due principally to the temperature which the substance attains during the process. The proteins are most affected, and 36 per cent of the digestible protein may be lost; carbohydrates are less affected, and fats least of all.—*Note in J. S. Chem. Ind. on an article in Chem.-Zeit.*

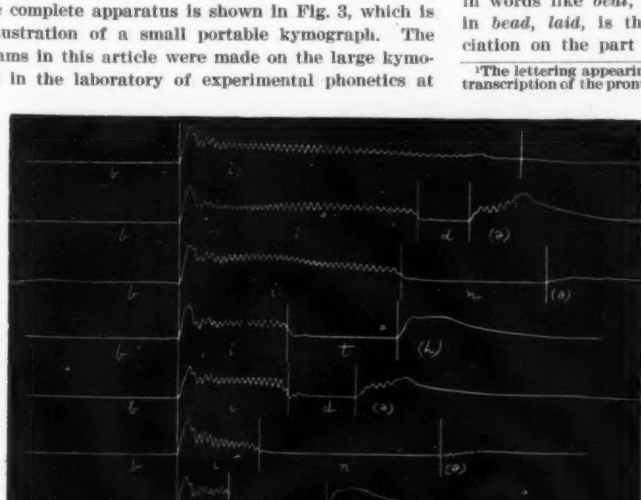


Fig. 5—Mouth-tracings of bee, bead, bean, beat, bid, bin, bit, showing length of vowels and final consonants

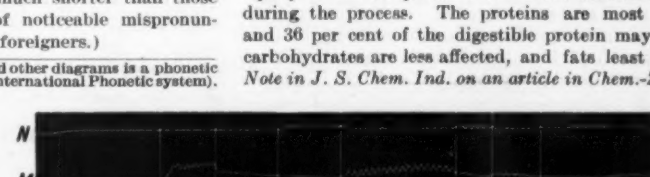


Fig. 7—Simultaneous nose, mouth, and larynx tracings of good morning (as said on parting)

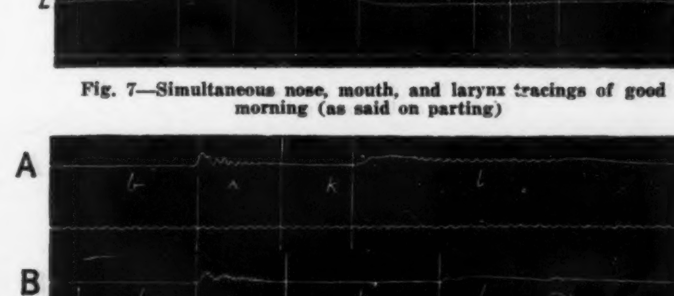


Fig. 8—A, mouth-tracing of English buckle (male voice); B, mouth-tracing of French boucle (female voice)

The Yellowing of Paper*

A Study of the Causes or Principal Factors Producing this Deterioration

By Alfred B. Hitchins, Ph.D., F.C.S., F.R.M.S.

A NUMBER of experiments have been carried out to determine the causes or principal factors bringing about the yellowing of paper. In this work handmade sheets were used, made from the finest picked white rags, and the chemicals used were all of c. p. quality, tested carefully for impurities and where necessary further purified. Particular care was also taken in the bleaching and washing of the stock, as it was realized that this in itself might have an influence on the yellowing of papers. The sheets were subjected to three test conditions.

Test No. 1—Exposure to arc light for one hour to 100 hours. Samples withdrawn at 10-hour intervals.

Test No. 2—Exposure to moist heat, 90° Cent. in a constant temperature oven in total darkness for 1 to 100 hours. Samples withdrawn every 10 hours.

Test No. 3—Exposure to dry heat 90° Cent., heated in a constant temperature oven in total darkness from 1 to 100 hours. Samples withdrawn every 10 hours.

It was thought desirable that as much as possible, only one side of the sheet should be acted upon, so the samples intended for exposure to light were sealed down to an opaque backing, and the sheets intended for exposure to heat were sealed down to thin asbestos boards. No filler was used for any of the experimental sheets. In this investigation the yellowing of paper due to the fading of dyes or the presence of woodpulp is not considered, all the sheets having been made without any dye.

For the charts used to illustrate the data obtained, the following nomenclature has been adopted: The ordinates headed Y° are degrees of yellowing. The abscissae represent hours of exposure. The lettering of the curves—A, B and C correspond to tests Nos. 1, 2 and 3—*viz.*: light, moist heat and dry heat. The degrees of yellowing were measured photometrically by means of a calibrated yellow wedge.

The sheets for experiment No. 1 were made without size and after subjection to the test conditions showed practically no yellowing.

The sheets for No. 2 were prepared with three different amounts of rosin—2½ per cent., 5 per cent., and 10 per cent. The result of the exposure to the test conditions is illustrated in Fig. 1. Evidently the degree of yellowing is dependent upon the amount of rosin present.

The sheets for experiment No. 3 were prepared with the same amounts of rosin, but with the addition of 1 per cent., 2 per cent., and 4 per cent. of iron to the alum. The results obtained are shown in Fig. 2.

For experiment No. 4, sheets were prepared with the same amounts of rosin and iron with the further addition of 2½ per cent., 5 per cent., and 10 per cent. of gelatin. These results are shown in Fig. 3.

The alum used to precipitate the rosin in all cases was iron-free alum, so that the effects of the different amounts of iron added could be observed.

A consideration of the results obtained leads to the conclusion that however carefully the paper is prepared, the addition of rosin alone as a sizing material will, in the course of time, produce yellowing. Also that the presence of iron is a very important factor.

The curves shown in Fig. 2 are all considerably higher where iron is present and the degree of yellowing is more or less proportionate to the amount of iron introduced. It is generally conceded that an animal-sized paper will yellow more than one which is free of gelatin sizing.

The result shown in Fig. 3 where definite amounts of gelatin were added bear this out very thoroughly. As the amount of gelatin is increased, so the degree of yellowing is increased. The form of the curve where gelatin is present is, however, of rather a different character. There is more or less of a tendency for a maximum amount of yellowing to take place within a given time, after which further yellowing is very slow or does not occur at all. It is obvious that light is the most important factor in the yellowing of paper. Next in order of importance is moist heat, and the least active of the three factors is dry heat. It is quite in keeping with theory that light should be the most potent factor in connection with the yellowing of paper. Rosin alone is to some extent sensitive to light, and rosin and iron compounds are undoubtedly very sensitive to light. The addition of gelatin also increases this sensitiveness to light action.

It is possible that the presence of gelatin acts as an

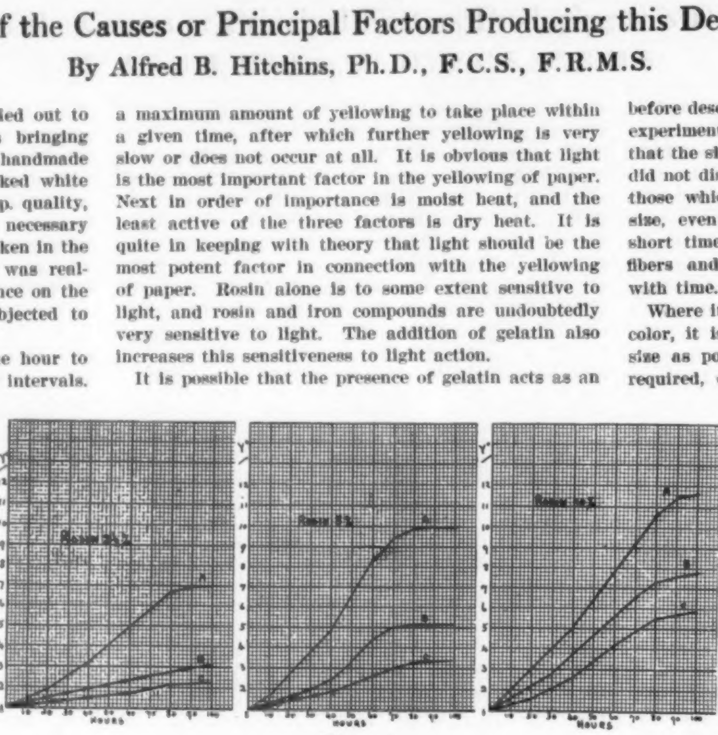


Figure 1

organic sensitizer in a manner somewhat analogous to its influence on the formation of a true photographic image. Microscopic sections were cut of the various samples of paper so that it was possible to examine the internal structure. In the case of the paper containing only rosin size, it was found under the action of light that the yellowing produced was only superficial, the interior of the paper being hardly discolored at all. Under the influence of heat the discoloration extended more deeply. In the case where iron was added in known quantities the discoloration penetrated a little more deeply into the structure and where the paper was gelatin-sized in addition to the rosin and

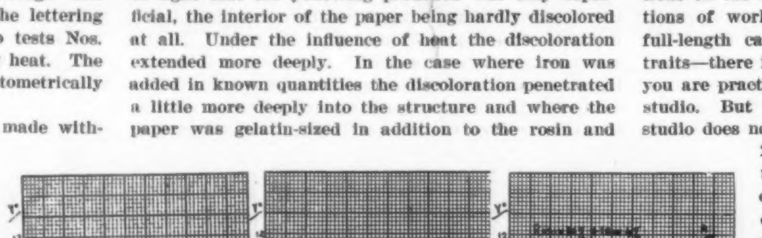


Figure 2

iron, the sheet was almost equally yellowed throughout. This also tends to prove that the gelatin has the power of acting in the manner of an organic sensitizer.

A general consideration of the data obtained confirms the work of Klemm, Zschokke and Schoeller, that the yellowing of paper is due to the formation of rosin-iron compounds, and that the amount of such compounds definitely determines the amount of yellowing to be expected. Schoeller has stated that in cases where the size is extracted early from samples so as to remove the yellowing compounds the paper will retain its original color. A number of the sample sheets were freed of rosin and subjected to the tests before described, in connection with the sheets made for experiment No. 1—*viz.*: without size. It was found that the sheet from which the sizing had been removed did not discolor greatly, but did not hold up as well as those which had never been sized at all. The rosin size, even if it is present in the paper only for a short time, undoubtedly has some influence upon the fibers and produces a certain amount of yellowing with time.

Where it is necessary that a paper retain its original color, it is obviously important to use as little rosin size as possible, consistent with the degree of sizing required, and to use always an iron-free aluminum sulphate as the precipitant. The animal sizing should be omitted or kept as low as possible.

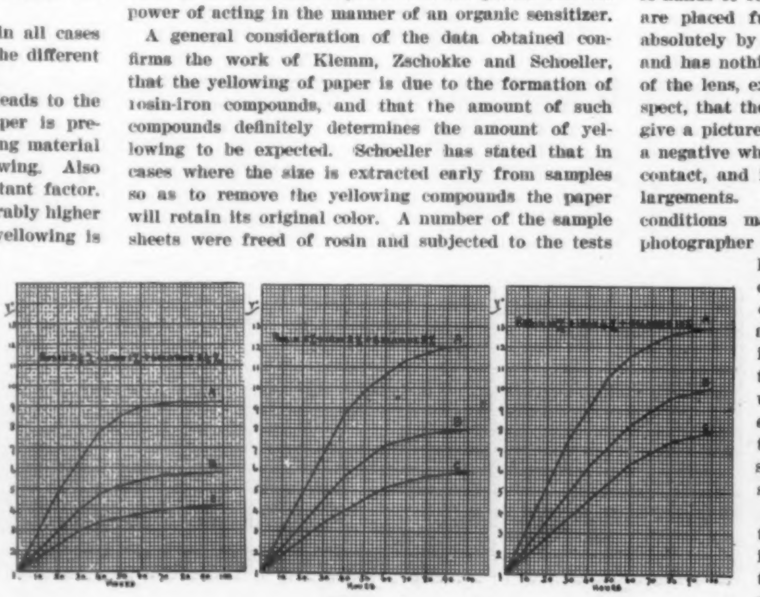


Figure 3

*Communicated to *Paper* from the Ansco Research Laboratory.

The Lens for a Studio

IT is evident that the choice of focal length of lens for a studio of given dimensions is one of those things in deciding which on paper many a photographer finds himself at a loss. His difficulty no doubt arises from insufficient knowledge of the conditions which are the best for the production of portraits of pleasing "drawing" or perspective; or, even if these latter are fairly familiar to him, inability to rely upon himself to carry out the really very simple arithmetical calculations which are concerned in the matter. Hence the questions which are addressed to us, and which, in many cases, can only be partially answered for the reason that the querist overlooks the fact that it is just as necessary to take into consideration the description of work which he is doing as it is to base calculations on the length of the studio. Where the descriptions of work vary considerably—for example, from full-length carte-de-visites to half-length cabinet portraits—there is no one best lens for the purpose unless you are practically unlimited as regards the length of studio. But where, as is most usually the case, the studio does not exceed an overall length of, say, 18 or 20 ft., it is necessary to choose a lens for the class of work which forms the bulk of the output; or, alternatively, to make a choice of focal length which covers all the requirements, but sacrifices a good deal in the way of the most satisfactory perspective. It should be clear to the photographer who gives the matter his consideration that the best course to follow is to choose the lens most suitable for the bulk of his work, and if the length of the studio does not permit of its being used for other descriptions of portrait, to supplement it by an objective of shorter focal length.

The crux of the matter lies in the fact that the pleasing character of the "drawing" in a portrait—that is to say the good proportion of hands or feet in relation to parts of the sitter which are placed further from the camera—is conditioned absolutely by the distance of the lens from the sitter, and has nothing whatever to do with the focal length of the lens, except in this very important practical respect, that the use of a relatively short-focus lens will give a picture which is too small on the plate, yielding a negative which is useless for the making of prints by contact, and is only of service for the making of enlargements. Inasmuch as the everyday commercial conditions make contact printing a necessity, the photographer must needs employ a lens of such focal length that the image on the plate is large enough for his purpose. It is on this account that the advice is often given to use a 10 or 12 in. focal length for the sake of its good perspective. The form in which the advice is given is somewhat misleading unless it is realized that the use of such a focal length compels the photographer to adopt a distance of the camera from the sitter at which satisfactory "drawing" is secured.

Broadly it may be said that this distance is about 10 or 12 feet. If the camera is never placed nearer to the sitter than this, there will be little occasion to complain of the exaggerated rendering of

hands or knees which is often evidenced in portraits which are taken at closer quarters. And if the work in a studio were confined to one particular description—e. g. cabinet heads, or full-length cabinets—it would be a very simple matter to say what is the best choice of focal length. But in view of the variety of work which falls to be done in most studios, it is necessary that the photographer should have a working acquaintance with the rules according to which he can quite easily calculate for himself the focal length which he should choose.

The foregoing considerations will perhaps be understood if it is borne in mind that, so far as the size of the picture and the focal length of lens required, the photographing of the human sitter is practically a species of copying upon a reduced scale, not quite such a precise operation as copying a flat drawing, but sufficiently amenable to the rules of copying for practical purposes. Thus, if we assume that a full-length standing figure on the average has a height of 68 inches and a "head-and-shoulders" a dimension of 30 inches, then the sizes of the images on the ground glass obtained for carte-de-visite, cabinet, and other sizes of print represent a range of degrees of reduction such as are set forth in the following table:

Name and Size of Photograph.	C. de V	Cabinet.	Boudoir.*	Imperial.†
Height of image on photograph..........	3	5	7½	9
For full-length portrait, reduction figure is	23	13	9	7½
For head and shoulders portrait, reduction figure is	10	6	4	3 nearly

* 8½ × 5. † 10 × 6½.

Now these reduction figures provide a very simple short cut to the calculation of the longest focal length which can be used within a studio working space of given dimensions. For here is the rule, and it is one which the photographer should have no difficulty in keeping in his mind: ***For practical purposes the distance from the sitter to the plate, whatever the focus of lens used, is the number of focal lengths represented by the reduction figure plus two focal lengths.*** For example, in the case of taking a full-length figure in carte-de-visite size (reduction figure, 23), the distance from the sitter to the plate will be twenty-five focal lengths of the lens. In the case of a "head-and-shoulder" cabinet portrait (reduction figure, 6), it will be eight focal lengths. This is not a perfectly accurate rule, for it gives results which are a little under the truth: the distance, if expressed in inches, will be an inch or two greater, but never sufficiently greater to affect the usefulness of the calculations. Now for the application of our rule. We are working, let us suppose, in a studio of 20 ft. overall length, and require to calculate what is the longest focus of lens we can use for full-length cabinet portraits. Obviously it won't do to base this calculation on the wall-to-wall length of the studio. There must be some allowance for space behind the sitter and also for the photographer behind the camera. A customary allowance for these two factors is 5 ft., which leaves us with 15 ft. for the permissible distance between the sitter and the plate. Very good. Then, according to our table and rule (the former tells us that the reduction figure under these conditions is 13), the distance from sitter to plate is fifteen focal lengths—that is to say, the greatest focal length which one can use is one which, when multiplied by fifteen, makes 15 ft.; in other words, 12 inches.

Let us make it clear that we are not tying the photographer down to the data in our table. We have adopted certain arbitrary standards, namely 68 and 30 ins. respectively for a full-length and head-and-shoulders figure, and the dimensions 3, 5, 7½, and 9 ins. as those of the height of the average portrait in C. de V., cabinet, boudoir, and Imperial photographs. But it is perfectly easy to construct a table which may be strictly in accordance with an individual photographer's average requirements—for example, in postcard work. All that is necessary, in order to obtain the reduction figure, is to divide the height of the subject by the height of the image required on the print; the quotient is the reduction figure corresponding with our 23, 13, and so on. The case of a group photograph will perhaps make this clear. Required to find the longest focus which can be used for taking a whole-plate group measuring 12 ft. across in a 20 ft. studio. The image on the whole plate will be, say, 8 ins. Twelve feet equals 144 ins.; 144 ins. divided by 8 equals 1/18th—that is to say, our reduction figure is 18. Allowing 5 ft. for placing of the group and for working space behind the camera, we have 15 ft. left, which distance, according to our rule, is 18 *plus* 2 equals twenty focal lengths. Fifteen feet equals 180 ins., which divided by 20 equals 9 ins.—the maximum focal length which can be used.—*British Journal of Photography.*

Nature's Factories for Sugar and Starch*

At this time we are much concerned with our national resources. Much of our business has been reorganized to supply the materials needed, and as a consequence, we think of the essential work in terms of manufacture and transportation, work that depends upon the activities of men. Of course all this work is essential, but it is made possible by a still more fundamental process which should be realized. Men could not work without food and materials, but few realize how these are produced. In fact, so little thought was given to food production before the war that our population was increasing very much faster than our food production. This was the most important material problem this nation was facing before the war, and it became very acute as soon as we entered the war.

If men cannot work without food, neither can they work without materials, and fundamental among materials are wood and coal. Food and wood and coal may be regarded as the basis of our activities, and still very few know how these essential things are produced. *They are made by green plants!* The results of the work of green plants are food used directly or transformed in the bodies of food animals, coal deposits, forests of timber. Green plants have sometimes been characterized as the mediators between death and life, and this is true in that through their work a dead world is transformed into a living world. They stand at the threshold of our life, of our resources and activities.

The word photosynthesis may not suggest its meaning to many people, but it stands for the most important process in the world. It is primarily the fundamental process of food production without which the world of organisms, including ourselves, could not live. Photosynthesis is chiefly the work of the foliage, because the leaves represent the greatest display of green tissue. To most of us foliage is simply a thing of beauty in a park or a landscape, but we must realize that it is also a laboratory for food manufacture, upon which the world depends. In this laboratory inorganic materials are built into organic substances, and upon these organic substances the green plants live and provide an excess sufficient to feed animals—and also those plants which are not green, such as the mushrooms and other fungi.

There are several general kinds of food as man classifies them, but the work of green plants has to do first and foremost with carbohydrates, such as sugar and starch—which, however, are in turn the basis for the manufacture of other foods.

The raw materials used in carbohydrate manufacture are about the most widely distributed materials on the earth; namely, water and carbon dioxide. The occurrence of water needs no explanation, while carbon dioxide is everywhere in the air. Green plants can manufacture food therefore wherever air and water are available. The land plants, with which we are chiefly concerned in the production of food for the human race, obtain water from the soil, and carbon dioxide directly from the air in contact with the leaves. An interesting fact in reference to these raw materials is that they are also "ultimate wastes" when food is being used. This means that when living bodies are using foods, carbon dioxide and water are excreted because they cannot be broken up in the body as a preliminary step to the formation of new combinations. From food to waste is the work going in all living bodies; from waste to food is the added work going on in all green plants.

The active agent in the manufacture of carbohydrates is the "chloroplast," which needs definition. Chloroplasts are minute green bodies within the cells that give green color to foliage. As the name suggests, they comprise two conspicuous substances: the plastid is the living substance (protoplasm), while the chlorophyll is a green pigment. The living plastid does the work, while the chlorophyll supplies the conditions for work; in fact, the chloroplast may be thought of as a chemical laboratory which uses raw materials in the manufacture of carbohydrates.

In order to work, the chloroplast must have a supply of energy, and this is obtained from sunlight. It is known that chlorophyll is able to absorb energy from light, for when light passes through it, certain rays are retained, and it is these retained rays that supply the energy with which the chloroplast works. It is an interesting fact that the rays of light not absorbed give a green color; that is, leaves are green because the green-producing rays are not being used. If the energy for photosynthesis is obtained from sunlight, it is evident that at night the process is suspended; in fact, many plants live through the winter without any opportunity to manufacture carbohydrates. It must be evident that a process which is suspended for a considerable period during every twenty-four hours, and which may be suspended for months, is not a process of living, for living must go on continuously. It is simply a manufacture that provides material used in the process of living.

The process of carbohydrate manufacture has been called photosynthesis because the word means "putting together in the presence of light." The first step in the process is the breaking up of water and carbon dioxide into their constituent elements. Water consists of hydrogen and oxygen, and carbon dioxide of carbon and oxygen. To break up these two substances in our university chemical laboratory requires a great display of energy in the form of heat or electricity, but it is accomplished by the chloroplast in the laboratory of the leaf without any unusual display of energy. Following this breaking up the raw materials, the freed elements are put together in new combinations, this being the "synthesis" referred to in the name. It must not be supposed that a carbohydrate is the result of the first synthesis, for it is reached only after a series of chemical changes.

The final product of photosynthesis is reached when a carbohydrate is formed. In the production of a carbohydrate, not all of the elements of the raw materials are used. As much oxygen is left over as entered with the carbon dioxide, and this oxygen is a by-product which is being given off when green plants are engaged in photosynthesis. (The name carbohydrate, meaning carbon and water, is given because it contains carbon and also hydrogen and oxygen in the same proportion as in water.) The total result seems to be to get the carbon out of the carbon dioxide and combine it with water, and therefore the process is often called the "fixation" of carbon; that is, getting carbon out of a gas and "fixing" it in a solid. Since hydrogen and oxygen are both gases, carbon is the only solid that enters into the fabric of the plant, and this solid is obtained from a gas that exists in the air.

The carbohydrates thus formed in the plants are usually starches or sugars, and they are freely transformed into one or the other. Starch is spoken of as the storage form, but when the carbohydrate is being used and is moving through the plant, it is in the form of sugar, for a substance must be in solution to be carried about, and therefore sugar is spoken of as the transfer form of a carbohydrate.

When it was first discovered that green plants take in carbon dioxide and give out oxygen, it was natural to suppose that this gas exchange represented the respiration of plants. Since the gas exchange in the respiration of animals is just the reverse, the opinion became current that plants and animals differ in their "breathing." Since this impression is still current, its correction should be emphasized. It is clear that photosynthesis has nothing to do with respiration, for respiration is associated with what may be called the act of living, and therefore is carried on by every living thing all of the time. If respiration stops, the plant or animal is dead; in fact, we use respiration as a sign of life. Therefore plants and animals "breathe" alike, both taking in oxygen and giving out carbon dioxide; but green plans carry on the process of photosynthesis also, in connection with which carbon dioxide is taken in and oxygen is given out. The confusion arose from the fact that during the day, when photosynthesis is going on, the amount of gas exchange involved in the manufacture of carbohydrates is so much greater than the amount involved in respiration, that the latter was not noticed. If the observation had been extended into the night, however, it would have been discovered that only the respiratory exchange was being carried on.

Carbohydrates are by no means the only foods that plants make, and therefore photosynthesis is not their only process of food manufacture. Another conspicuous group of foods is the group of proteins, which may be regarded as foods in the most advanced stage as living protoplasm is largely composed of proteins. Carbohydrates, therefore, may be thought of as the first stage of food, and protein as the last stage. It is known that neither light nor chlorophyll is required for the manufacture of protein, for the process goes on in living cells removed from light, and in plants containing no chlorophyll. It is known, however, that carbohydrates are used, and that to the carbon, hydrogen, and oxygen supplied by them, the elements nitrogen, sulphur, and often phosphorus are added, and these elements are obtained from their combinations in the salts of the soil.

The rôle of green plants in the world, therefore, is evident. It is only by them that food can be made from that which is not food. For this reason they are the only independent organisms, that is, independent of the work of other organisms. When we see the phrase "nothing but leaves," with its implication of failure, we must realize that leaves stand for the most fundamental of all the work of the earth, without which there would be no world of living beings.

*American Museum Journal.

The Mineral Elements in Animal Nutrition

(Continued from page 219)

cows. The milch cow greatly excels any of the other farm quadrupeds in the rapidity and efficiency with which she produces proteid and mineral nutriment. This unrivaled productive capacity calls for unusual supplies of the kinds of nutriment involved. So far as protein is concerned this requirement is amply recognized; but, with almost no evidence on the subject, we have assumed that the cow's mineral requirements are fully met without any attention being given to the matter. Our results show this assumption to be unwarranted and untrue.

Six cows were used in this study, in two groups of three each. Each cow was taken through three experimental periods, usually of 19 or 20 days' duration, separated by 10-day intervals. The excreta were caught by attendants sitting behind the cows. Complete ash analyses, as well as ordinary proximate analyses, were made on foods, milk, urine, and feces.

We found that liberal milk production, on common practical winter rations fed in quantities sufficient to maintain the liveweight and to cause regular and extensive nitrogen and sulphur storage, caused large and consistent losses of calcium, magnesium, and phosphorus from the skeleton. These losses occurred in spite of liberal supplies of these nutrients in the food. The very limited response of the cows to large increase in the intake of these elements suggests that the selective improvement of the milch cow, for milk production, has outrun her capacity to digest mineral nutrients. A further study is in progress in which we hope to learn whether under any circumstances it is possible to protect the cow from loss of minerals during heavy milk production.

An extensive metabolism of silicon was demonstrated; and an excess of inorganic acids over inorganic bases in the ration, due largely to the silicon of timothy hay, caused an acid reaction and an increase in the ammonia of the urine.

From this study it appears that a failure to maintain mineral equilibrium must be so common among cows of the more profitable sort that it may be considered a normal condition during the time of larger production, at least if this occurs during the winter, that is, while the cows are off from pasture.

A common failure of cows to maintain exceptionally high production during consecutive periods of lactation may be due to mineral depletion, as may also be a frequent failure of cows to breed after having been subjected to a period of forced production, as in the establishment of records.

Since extensive milk production is sustained, in part, by drafts upon the mineral reserves of the body; since this process cannot continue indefinitely; and since there is in cows a gradual shrinkage and final cessation of milk production coincident with this depletion of nutrient reserves, it is believable that this mineral exhaustion may be among those factors which cause the gradual shrinkage of milk, and that by preventing, as largely as possible, these losses from the body we may be able to lessen the shrinkage and to extend the duration of the production of milk.

The results of this study indicate that especial attention should be given to the calcium, magnesium and phosphorus contents of the rations of heavily-producing cows, in order that the loss of these elements from the skeleton may be kept as low as possible; and a liberal supply of foods rich in these elements should be allowed after a cow has ceased to produce heavily, during the latter part of the period of lactation, in order to refund previous overdrafts before the birth of the next calf.

It is impossible, of course, to draw any one conclusion which will express the full significance of so varied a program as that which I have reviewed with you, but to me the results of these studies have appealed, more than in any other way, as related to the service of lime and legumes in agriculture.

Calcium is very much the most abundant mineral in the animal body. Physiologically it is the great mineral stabilizer. Practically, it is much more frequently lacking in the food of men and animals than is any other mineral nutrient. Lime as applied to the soil liberates organic nutriment and enriches the grass in calcium. It stimulates the growth of grass and makes it a better food for animals. In a sense, "All flesh is grass." Lime also maintains in the soil conditions favorable for the growth of legumes. The legumes draw heavily upon this lime and furnish it to animals in quantities not approached by any other food plants. Through the activity of the bacteria which cause their root-nodules they are enabled not only to store nitrogen in abundance but also to feed the grasses with which they are associated. Thus the lime in the soil favors the growth of legumes. Lime and legumes favor the growth of grass. Grass and legumes control the breeding of livestock. Grass, legumes, and livestock control the destinies of nations.

Ocean Temperatures and Seasonal Weather in Southern California

By Wm. E. Ritter and Geo. F. McEwen

(Extracts from open letter, dated La Jolla, Cal., Nov. 8, 1918)

So much does the well-being of the people of California and the whole western United States depend on the amount of precipitation and its time of occurrence each season, that even small, if trustworthy, [advance] indications would be valuable.

The researches on the ocean water off the coast of Southern California prosecuted by the Scripps Institution during the last 10 years, coupled with the United States Weather Bureau records for the same time, bring to light somewhat suggestive facts.

Stated very briefly, they are these: During July, August, September and October, 1917, the temperature of the sea at the institution averaged about 5° F. higher than for the same months of the preceding nine years, and the force of the northwest ocean wind for the same time was about 20 to 30 per cent. below the average.

These exceptional conditions of water and wind were followed, as is well known, by exceptional weather conditions of the ensuing winter months. There was almost no rain until January, 1918, and the total precipitation was low for all California.

The conditions of sea and wind for summer and fall months of 1918 have repeated in essential features the conditions of those months for 1917.

As to the character of the data, there can be no question so far as concerns the sea temperatures at La Jolla for the period of February, 1916, to the present (November, 1918). Six temperatures a day, distributed evenly through the 24 hours, every day in the year except Sundays, are taken at the outer end of the institution pier; that is, where conditions are almost typically oceanic. In addition to this extensive and systematic series of temperatures many are taken at numerous stations near shore and offshore to a distance of 75 to 100 miles from Point Conception to far south of the United States-Mexico boundary line. For the time previous to the completion and utilization of the pier, all temperature observations were of the distributed, intermittent kind, though in the aggregate large numbers were made.*

The defectiveness of the data in this case is the small number of years and the narrow area over which the observations extend. To give such data high predictive value, they would have to be extended over many years and over a far larger portion of the ocean.

As to the question of whether there are known cases elsewhere of connection between peculiar weather conditions on land and peculiar conditions of the ocean, it is to be said that while knowledge in this field is exceedingly meagre, some of what we do possess indicates strongly the existence of such connections, and that investigations carried on long enough and widely enough will make possible seasonal and long range weather forecasting on the basis of a combination of atmospheric and oceanic observations much as daily forecasts are now made from observations on the atmosphere alone.[1]

The Testing of Cotton by Steaming

CUTTINGS of cotton cloth were treated with solutions of various alkaline salts, dried, and steamed, then compared with a scale of standard whites prepared by staining a good white cloth with known quantities of diluted scouring liquor. Fats play no appreciable part in the yellowing of the goods during steaming. Treatment with sodium ricinoleate causes a slight lowering of the color. As regards the behavior of the "gums," both dry heating and steaming cause a yellowing of cotton at all stages of the scouring and bleaching process, the discoloration due to steaming increasing with the time. The presence of alkali intensifies the yellowing. Fully scoured cotton is discolored only slightly less than the raw goods; in this respect the non-cellulose impurities differ but little from the cellulose. Chemicked goods show the strongest discoloration, those bleached cold show it more strongly than those bleached warm and acid; goods bleached warm with an excess of soda in sodium hypochlorite are relatively less subject to yellowing. Mercerised goods keep their color well in spite of their greater attraction for water. Oxycellulose becomes quite brown on steaming, about 100 times darker than cellulose; hydrocellulose is ultimately discolored less than cellulose. By steaming cotton treated with sodium ricinoleate comparatively with the untreated sample and observing its discoloration, a relative measure of the proportion of oxycellulose present is obtained. The main cause of the yellowing of cotton is the presence of β-oxycellulose.—*Note in J. Soc. Chem. Ind. on an article by M. Freiberger in Färb.-Zeit.*

*Cf. Summary and interpretation of hydrographic observations made by the Scripps Institution for Biological Research of the Univ. of California, 1908-1915. Univ. of Cal. Pubs. in Zool., Dec. 6, 1916, v. 15: 255-356, pls. 1-38.—Ed.

[1]Those who would like further information relative to oceanic conditions and their relation to the weather will find a popular treatment of these subjects in Bull. No. 7, of the Scripps Institution for Biological Research of the University of California, at La Jolla, Cal., by George F. McEwen, oceanographer, entitled: "Oceanic Circulation and Its Bearing Upon Attempts to Make Seasonal Weather Forecasts: a Sketch of Observational Methods and Explanations." The paper is now in the press and will soon be ready for distribution by the Scripps Institution.

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Table of Contents